JULY, 1956

WORLD OIL

SPECIALIZED FOR EXPLORATION, DRILLING
PRODUCING OPERATIONS AND MANAGEMENT

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WORLD OIL

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a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **The Mexican oil industry has a running start** toward one of its most successful years since the boom days of the 1920's. In a personal interview with World Oil, Pemex Director General Antonio J. Bermudez gives location of 17 new fields discovered so far this year—total wells drilled and number of successes so far in 1956—plans for stepped up drilling activity—and many more highly informative statistics, all revealed for the first time this year. For complete details on Bermudez' report, turn to **Page 40 . . . Mexico Steps Up Booming Oil Activity . . . . . Don E. Lambert**

☐ **It was a "big deal"**—even for the oil industry that was closed recently by The Atlantic Refining Company and Houston Oil Company of Texas. Atlantic acquired Houston Oil's producing and non-producing properties involving an area larger than Rhode Island. For them Houston Oil will net about $200 million. The transaction was carried out by several hundred people working for five months. They handled 25,000 copies of deeds and other legal documents containing 2 million pages. Transfers of title to more than 6000 separate properties were recorded in some 155 counties in 10 states. **Big Deal! . . . . . Page 43**

☐ **U. S. oil companies** now hold substantially more petroleum reserves in foreign fields than in domestic fields. Domestic and foreign oil reserves of 37

Turn the Page ▸

THIS MONTH . . .

U. S. companies exceed 84 billion barrels. Total oil reserves of all companies lying within the U. S. are about 35 billion barrels. Five "international" companies have 65 billion barrels of reserves, or 77 percent of the 84 billion held by 3 companies. Oil and gas reserves have become increasingly important to companies in the petroleum industry of the U. S. The value of proved reserves is greater than formerly. This is true because the cost of finding and developing petroleum has increased sharply in recent years. **U. S. Firms Have More Foreign Than Domestic Reserves**.....**Page 44.**

Crude Price Hikes Unlikely

☐ With a record consumption more than offset by excessive imports and refining operations, U. S. crude oil prices are likely to remain at their current levels. Trend in gasoline supplies is particularly significant. Despite record consumption, stocks have not been reduced as rapidly as they should for this season. Crude imports for first five months of '56 are 18.1 percent above the '55 rates. In contrast, U. S. crude production is up only 5.4 percent over '55. Texas producers have been especially hard hit, but some relief is in sight. See **Report from the Observatory** on **Page 67.** Then turn the page for an all-inclusive picture of economic trends and operating levels. The charts on **Pages 68 and 69** give you the U. S. trends in all major operations of the industry, with comparison of current trends with year-ago levels.

☐ **Fluid injection methods** have become increasingly important in the U. S. reserves economically recoverable by fluid injection are estimated at 12 billion barrels. By producing them, the country will increase by 40 percent the amount of oil that would be recovered henceforth from presently known fields through primary methods. The primary reserves are estimated at 29.7 billion barrels. **Fluid Injection Expands U. S. Oil Resources**.....**Page 46**

☐ **Here is an outstanding analysis** of modern industry's executive manpower problem. For a revealing study of the growing trend toward more management development programs, sources, sources of executive material, and many excellent ways to develop executive talent, turn to **Page 52. What Are We Doing About Middle Men of Management?**.....**Joseph M. Trickett**

☐ **Here is an appeal** to the oil industry, especially those in the Mid-Continent area, to contact the Bureau of the Budget at Washington, D. C., their congressmen and senators, to urge adequate appropriations in the 1958 budget to enable the Bureau of Mines Petroleum Experiment station at Bartlesville, Okla. to continue its vital work. The reasons for this appeal are revealed in the article on **Page 62. Bureau of Mines at Bartlesville Faces Curtailment of Activities**.....**Anthony Gibbon**

EXPLORATION ARTICLES

☐ **Many problems in the Appalachian area** can use gravity surveys to advantage. The Niagaran reefs are known to be present in parts of this area and the gravity method has proved its ability to map such reefs. A description of the method and gravity maps are presented in the article beginning on **Page 75. Reefs Are Hard to Find**.....**Richard A. Pohly**

☐ **What about Arizona?** The newest oil state of the U. S. (August, 1954) has been battling, among other handicaps, the lack of markets, isolated areas of promise, and high costs of drilling and exploration. But, with an estimated four-fifths of the state perhaps covering a vast oil reserve, what about the future? Turn to **Page 80. Arizona . . . Boom or Bust?**..**Cloyd W. Swapp**

DRILLING ARTICLES

☐ **The 40-inch induction log** proved to be the most efficient device for determining true resistivity of the formation under most conditions of bedding and filtrate invasion. For an indication of how the various logging devices compared under controlled tests, turn to **Page 95. How Do the Various Logging Devices Compare When Determining True Resistivity?—Maurice Martin and J. L. Dumanoir.**

☐ **Turn to Page 112** and read how the contractor by carefully planning the electrical system for a rig, using only approved wiring fixtures, and by enforcing a rigid maintenance program can . . . **Eliminate Electrical Hazards**.....**W. R. Scrimes**

☐ **Drilling in water 112 feet deep,** the greatest depth so far attempted, the CATC Group is using a new method of adding stability to the drilling plat-

WORLD OIL, published every month except semi-monthly in February and August. Entered as THE OIL WEEKLY as second class mail matter December 23, 1916, at post office at Houston, Texas, under the act of March 3,1879.

form. The piling is slanted outward one foot for each six feet of vertical depth. Read more about this drilling in deep water in . . . **Platform Has Slanted Piling for Deepest Gulf Drilling**.....**Page 116**

☐ **Combination rigs** are used when drilling problems become severe in the predominately cable tool country of the Michigan Basin. Drilling through the unconsolidated glacial drift, and high-volume water sands present quite a problem to cable tool operators. These problems are solved by use of rotary tools while advantages of cable tools are retained for lost circulation zones and completion work. Turn to **Page 118** and read how one contractor minimized his problems in this area. **Combining Rotary and Cable Tool Drilling—Vance W. Orr.**

☐ **Various operating factors** in the field influence the original selection of a particular wire rope construction. Of these, bending is probably one of the most important. For information on the effect of bending on wire ropes, turn to **Page 122. How Bending Stresses Affect the Selection of Sheaves and Drums for Wire Ropes**.....**C. M. Zerr**

PRODUCTION ARTICLES

☐ **Gas storage in deep-seated semi-depleted oil reservoirs** may prove to be an efficient means of secondary recovery. Turn to **Page 135** for a discussion of gas injection and production procedure in estimating gas storage capacity of a reservoir, and ultimate oil recovery from gas storage. **Put Your Stored Gas to Work . . . at a Profit—A. B. Cook, R. H. Coulter, Jr., G. B. Spencer, T. M. Chin and W. C. Elliott, Jr.**

What a difference a decimal makes . . .

On Page 135, the third paragraph, second sentence should read: "After replugging all abandoned wells and reconditioning wells for the storage project, the reservoir was repressured to 2931 psia by the injection of 5.087 billion cubic feet of natural gas. The decimal point was omitted in the final figure. On Page 142, the third paragraph should read . . . "the calculated volume of injection gas necessary to raise the reservoir pressure from 144 to 2931 psia is 4.336 billion cubic feet" and not 4,336 billion cubic feet. WORLD OIL regrets these errors which are contrary to the authors' original manuscript.

☐ **Greater economy and efficiency** can be expected through the proper care and handling of tubing strings. Beginning on **Page 145** is some valuable information on recommendations based on observations and experience of both the manufacturer and the large users. **How to Care for and Run Tubing**....**R. J. Stoup**

☐ **Here are some handy nomographs** for making rapid estimates of the volumetric equation without the use of a calculator or slide rule. Turn to **Page 148** and find out how to solve problems with these useful tools. **Nomographs Make Reservoir Estimates Quick and Easy**.....**Keith D. Sheppard**

☐ **Requests for information** on long-stroke hydraulic pumps have resulted in this useful reference for production men. It not only answers many questions, but also provides pertinent engineering data on operation, performance and installation. As an additional aid, a sample installation is engineered step-by-step. **Page 152. Looking Over the Long-Stroke Hydraulic Pumping Unit**.....**Douglas M. Jones**

INTERNATIONAL ARTICLES

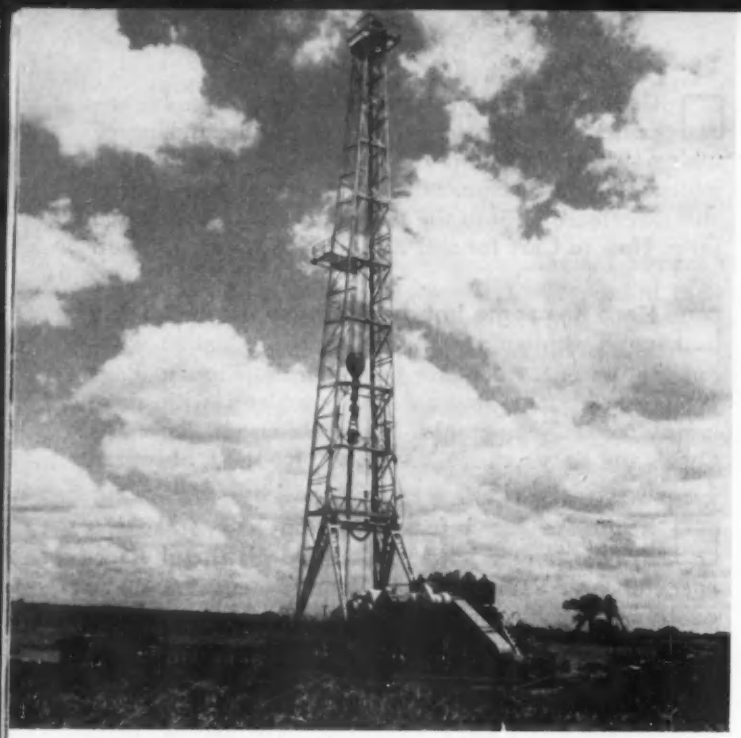
☐ **India has a problem:** It cannot develop its own oil resources without outside help. While the U. S. delays in acting on Indian requests for help, Russian technical experts are speeding their assistance. To prevent India's capitulation to the Communist concept, a suggested solution is that the U. S. oil industry sponsor its own technical aid program through an industry committee outside the framework of U. S. government agencies. See **Page 173. U. S. Oil Industry Called Answer to Indian Problem**.....**Henry Carter Rea**

☐ **Discoveries of new oil sources,** favorable geological indications of others and a rising domestic demand for crude products—which outpaces supply by 93 percent—are combining to heighten a spirit of optimism in Morocco. See **Page 176. SCP Finds 5 New Oil Areas in Morocco During 1955**. .**Dr. Maurice Moyal**

☐ **Recently Russia introduced gamma ray logging** equipment into Rumania—a technique used in the U. S. for the past several years. For exclusive photos of this equipment—all Russian-made—in operation, turn to **Gamma Ray Logging in Rumania**.**Page 178**

☐ **Twenty-one canyon crossings,** 8 underwater crossings, and 13 suspension bridges plus a 7-mile section on an almost perpendicular mountainside have caused the Buenaventura-to-Cali pipe line in Colombia to be called one of the roughest of its size ever built. Total length of the line is 64 miles. **Colombian Pipe Line One of the Roughest**.....**Page 182**

Turn the page for a Quick Look at what's ahead in WORLD OIL ➡



The Cuban oil story is a part of the detailed roundup of world oil operations to be presented in the August 15 International Outlook Issue of WORLD OIL. Above is one of the largest rigs ever taken to Cuba. It was used by C. J. Simpson Drilling Company of Cuba to drill a well for Cuban American Drilling and Exploration Company in Las Villas province.

NEXT MONTH . . .

World oil developments and progress invariably affect the pocketbooks and plans of domestic operators as well as those which operate abroad, together with the executives and employes of all. It is, therefore, of prime importance that the oil industry's personnel keep abreast of their industry's developments on a global scale.

WORLD OIL's International Outlook Issue, to be published August 15, is designed to meet that need. This feature-packed special edition, which will be combined with the annual Mid-Year Outlook Issue covering latest data on inside-U. S. operations, will offer numerous "special" articles, including:

- A detailed analysis of the Canadian oil industry complete with large insert map of Western Canada showing townships and ranges.
- The most thorough-going reports on individual Iron Curtain countries yet published.

In addition to these, many other articles will be published on important phases and trends of the world oil industry. The section devoted to complete reports on 1955 and 1956 oil operations in every country where oil is sought and/or produced will be of current interest, just as will stories on the U. S. import situation and the authoritative mid-year drilling survey and forecast. Remember, watch for two WORLD OILS in August . . . the regular August 1 issue and the . . .

International Outlook Issue
To Be Published August 15

WORLD OIL

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PETROLEUM REFINER and THE REFINERY CATALOG for the refining-natural gasoline-petrochemical industry.

PIPE LINE INDUSTRY and the PIPE LINE COMPOSITE CATALOG (first edition to be issued in July, 1957) for the oil and gas pipe line industry.

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Editorial Assistants: Joan Frandolig, Mary Stuart Warren, Fern C. Reed.
Librarian: Eunice M. Okoneski.

ADVERTISING

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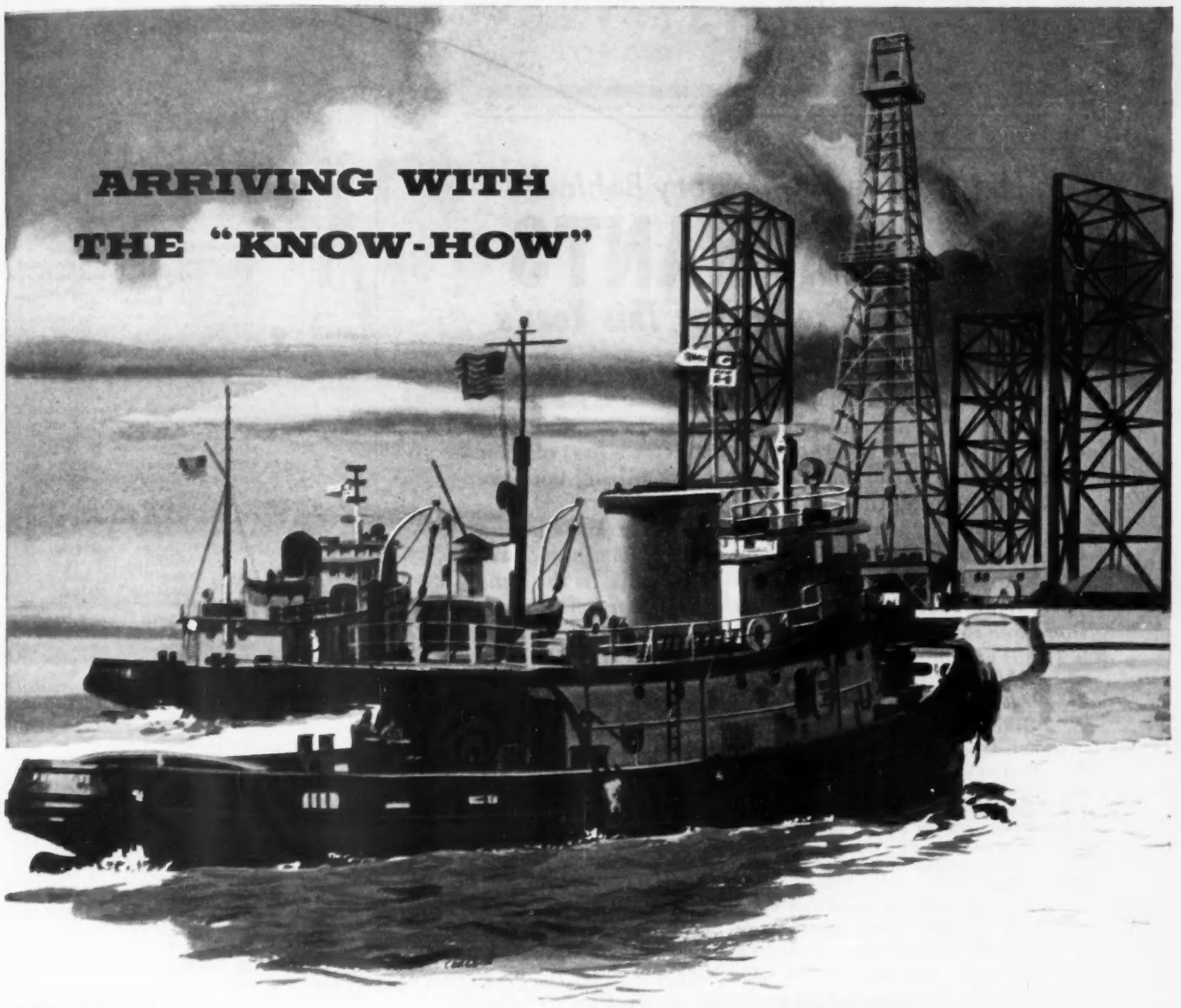

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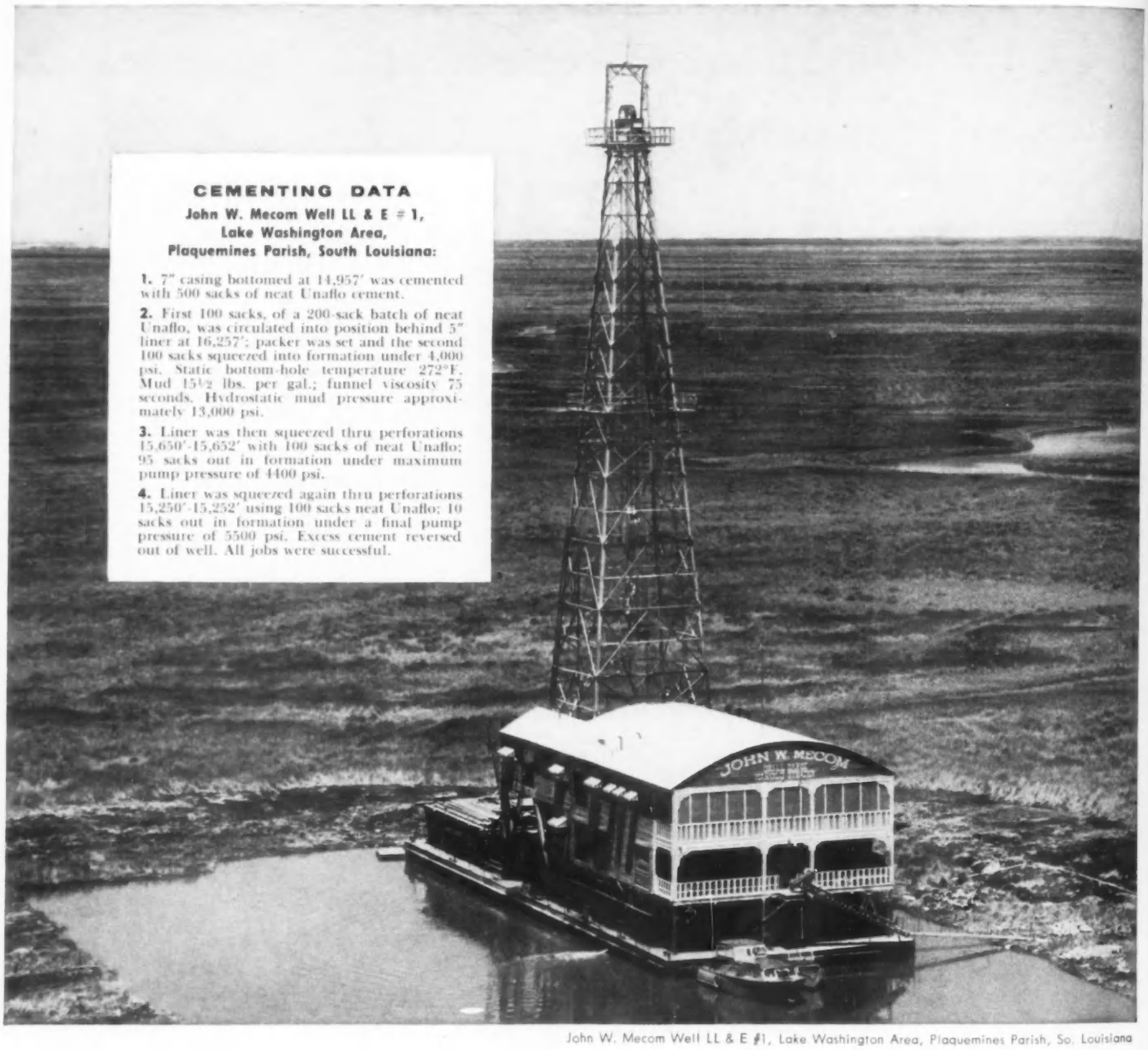
WHO'S MEETING WHERE

JULY	
18–20	Yellowstone-Bighorn Research Association, Third Professional Short Course on Uranium Occurrence and Structural Geology, Red Lodge, Mont.
AUG.	
2– 4	Annual Oil and Gas Institute, University of Colorado, Boulder.
SEPT.	
5– 7	Wyoming Geological Association, Eleventh Annual Field Conference, Jackson Lake Lodge, Moran, Wyo.
6– 7	API Oil Industry Information Committee, Conrad Hilton Hotel, Chicago.
7– 8	Association of Desk and Derrick Clubs of North America, Fifth Annual Meeting, New Orleans.
12–14	National Petroleum Association, Annual Meeting, Traymore Hotel, Atlantic City, N. J.
20–21	Annual Membership Meeting, Louisiana-Arkansas Division, Mid-Continent Oil and Gas Association, Roosevelt Hotel, New Orleans.
23–26	American Society of Mechanical Engineers, Petroleum Mechanical Engineering Conference, Statler-Hilton Hotel, Dallas, Texas.
26–28	Rocky Mountain Association of Geologists, Fall Field Trip, Southeastern Colorado, Denver.
30-Oct. 2	American Congress on Surveying and Mapping and American Society of Photogrammetry, Fall Convention and Co-Exhibit, Shirley-Savoy Hotel, Denver.
OCT.	
2– 3	Texas Mid-Continent Oil & Gas Association, 37th Annual Meeting, Rice Hotel, Houston, Texas.
7– 9	American Association of Oil Well Drilling Contractors, 16th Annual Meeting, Texas Hotel, Fort Worth, Texas.
14–17	AIME, Petroleum Branch Fall Meeting, Biltmore Hotel, Los Angeles.
14–20	Oil Progress Week.
18–21	Permian Basin Oil Show, Ector County Coliseum and Fair Park area, Odessa, Texas.
22–24	Rocky Mountain Oil & Gas Association, Annual Convention, Cosmopolitan Hotel, Denver.
22–26	National Safety Congress and Exposition, Conrad Hilton, Congress, Morrison and La Salle Hotels, Chicago.
23–26	National Association of Corrosion Engineers, South Central Region, Gunter Hotel, San Antonio, Texas.
29-Nov. 1	Society of Exploration Geophysicists, National Convention, New Orleans.
NOV.	
8– 9	American Association of Petroleum Geologists, Society of Exploration Geophysicists, and Society of Economic Paleontologists and Mineralogists, Pacific Section, Ambassador Hotel, Los Angeles.
12–15	API, 36th Annual Meeting, Conrad Hilton and Palmer House Hotels, Chicago.
19–20	AIME, North Texas Section, Symposium on Secondary Recovery, Wichita Falls, Texas.
25–30	American Society of Mechanical Engineers, Statler Hotel, New York.
1957	
APRIL	
6–11	Petroleum Equipment Suppliers Association, Palm Springs, Calif.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

Current Outlook Section

The odds are it's a *LUFKIN*



CEMENTING DATA

John W. Mecom Well LL & E # 1, Lake Washington Area, Plaquemines Parish, South Louisiana:

1. 7" casing bottomed at 14,957' was cemented with 500 sacks of neat Unaflo cement.

2. First 100 sacks, of a 200-sack batch of neat Unaflo, was circulated into position behind 5" liner at 16,257'; packer was set and the second 100 sacks squeezed into formation under 4,000 psi. Static bottom-hole temperature 272°F. Mud 15½ lbs. per gal.; funnel viscosity 75 seconds. Hydrostatic mud pressure approximately 13,000 psi.

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Looking Ahead . . .

. . . **Excessive supplies of petroleum in the form of crude oil or products, or both, are threatened.** The threat is indicated by scheduled increases in both domestic crude production and imports of crude. While supplies will be increased, demand for oils will continue seasonally low for the next several months.

•

. . . **This present threat of surplus petroleum is the result of huge world oil producing ability.** Pent-up production in the Middle East, Canada, Venezuela, and the U. S. is seeking a market. Imports into the U. S. are large and increasing. Domestic crude production has been curtailed drastically in an effort to avoid surplus supplies. But imports have increased, making the threat of surpluses ever-present, in spite of lower domestic production.

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. . . **The Texas Railroad Commission at mid-June ordered an increase of 70,973 barrels daily** in the Texas allowable crude production for July. The order was issued in the face of recommendations by most major crude purchasers that quotas be further reduced. There had already been four successive months of decreasing allowables. Based on 16 producing days in July, the new average allowable per calendar day was 3,322,043 barrels daily.

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. . . **Olin Culberson, member of the Texas Railroad Commission, declared that the time had come to stop reducing Texas oil production** "while at the same time witnessing increasing imports and increased allowables by other states." Crude imports have reached a new high of about 1,120,000 barrels daily, he said. Additional increases in imports are certain, he added, "if we again reduce the allowable production for July . . . There is a point beyond which this commission cannot go in reducing the allowables for the state without seriously crippling a great many producers. That point has been reached."

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. . . **Reports of importing companies to the Texas Railroad Commission indicated that they brought into the U. S. 1,187,048 barrels daily** of crude oil and products in May. Forecasts call for total imports averaging 1,287,809 barrels daily in June; 1,233,301 daily in July; 1,194,266 daily in August; 1,216,601 daily in September; and 1,290,940 daily in October. Those estimates were 12,575 to 42,768 barrels a day higher than the forecasts offered a month previously.

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. . . **The market for domestic crude will average 6,925,000 barrels daily** for June-July-August, forecasts the Independent Petroleum Association of America. This would be 350,000 barrels a day or 5 percent below the March level. Total domestic and export demand for petroleum will be down seasonally to 8,600,000 barrels daily. Imports of crude oil alone (excluding product imports) are scheduled at a record high of 1,035,000 barrels daily for the three months. That would include 180,000 barrels daily of West Coast receipts and 855,000 daily east of the Rockies. It would be 252,000 barrels daily or 32 percent over the same months of 1955 and a sharp increase in the ratio to domestic production. Estimating June crude production at 7,100,000 barrels daily, IPAA figures July and August market for domestic crude at 6,840,000 barrels daily.

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. . . **A federal biennial Census of Production and Distribution would be started in 1957** under a proposal of the Associated Business Publications. It would provide current statistics every two years. The present Census of Business is scheduled every five or six years, and is slow in coming out. Latest complete data reflect conditions of eight years ago.

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. . . **Western Canada is one of the most promising areas today** for the discovery of petroleum. Present production of 485,000 barrels daily from Canadian fields will some day appear very small, it is predicted. With rapid development of pipe lines and refineries, it is expected to be only a few years until the full productive capacity of Western Canada is unleashed. Western Canadian oil reserves are estimated around 3 billion barrels. The Pembina field of Alberta is credited with about 1 billion barrels.

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. . . **Heating oil demand is being further expanded.** It is forecast that 700,000 new users of oil heating units will be added during 1956.

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. . . **Oil production from water-flood operations in the U. S. has increased** during the past four years from 220,000 barrels daily to 356,000 barrels per day. It will reach a peak of 2,055,000 barrels daily in 1980. This estimate is based on a predicted curve for the future, considering the past history of water-flood production. Total U. S. water-flood production of 32½ billion barrels from all water-flood operations is predicted. Most of this future water-flood oil will come from Texas, Louisiana, California, Illinois and Oklahoma. For more about the oil available for recovery by fluid injection see the article on Page 46.

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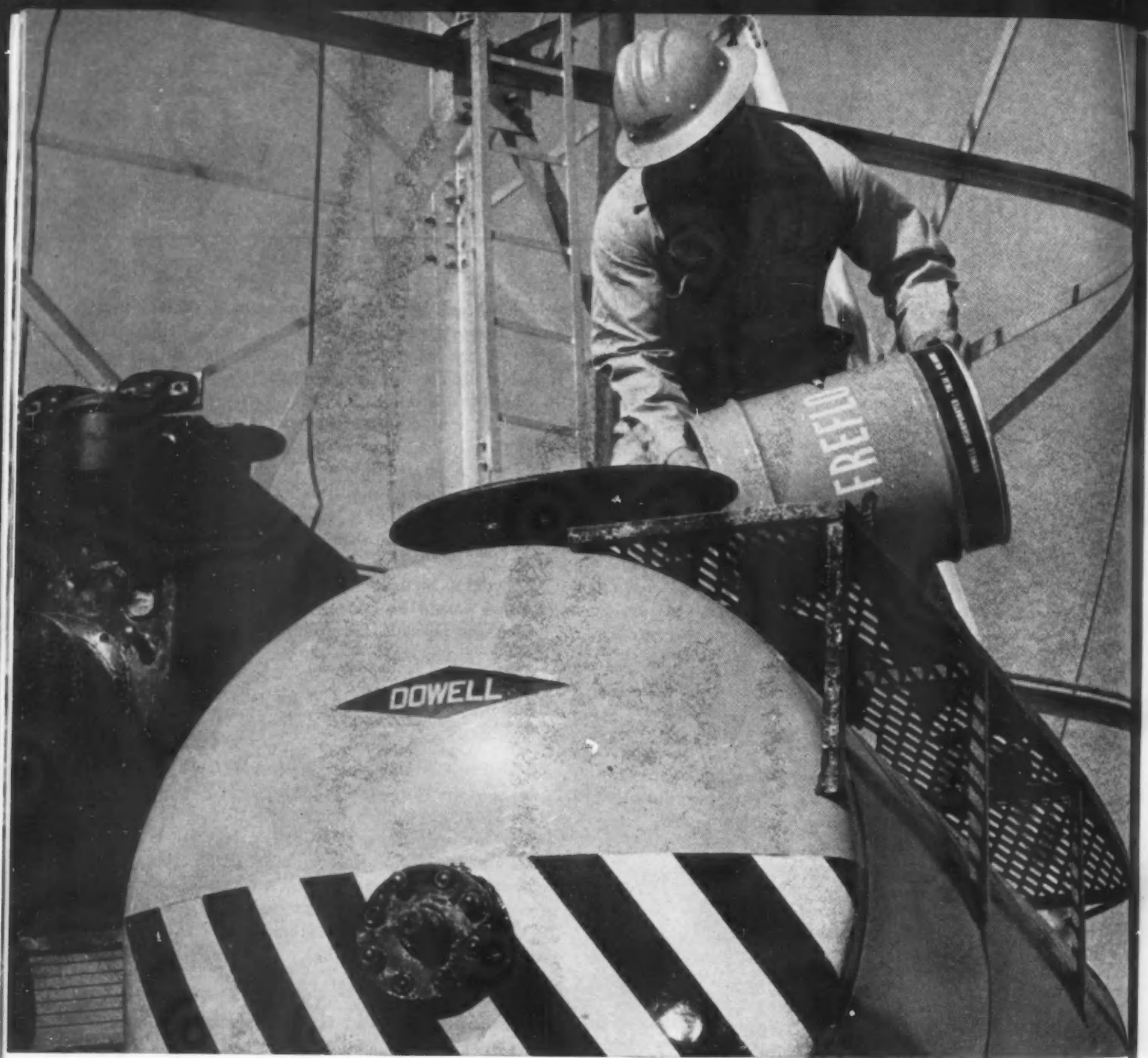
. . . **Sulfur price cutting confronts U. S. oil operators** interested in sulfur. Prices have been cut by Mexican and U. S. producers, since extension of the Frasch mining process to Mexico. In 1954 Mexico produced 86,000 tons of sulfur, the U. S., 6 million. Mexico boosted output to 516,000 tons in 1955; will produce 944,000 in 1956; 1,310,000 in 1957; 1,605,000 in 1958.



One 10-gallon drum of Freflo diluted with oil makes 1000 gallons of treating fluid . . . average treatment: about 20 gallons of Freflo in 40-48 barrels of oil.

UNLOCKS WATER BLOCKS

FREFLO*, a new Dowell product, could well be the answer when you face production problems that indicate the possible presence of a water block.

For example, problems like: (1) No production after completion, although a good show was obtained when the well was drilled in. (2) Loss of production after re-working. (3) Loss of production after prolonged shut-in. (4) An abnormal production decline.

Freflo eliminates water blocks by reducing the water's surface tension and lowering the interfacial tension between water and oil. Freflo also helps to dissolve asphalt or paraffin deposits.

Freflo is easy to use—requires no special well equipment or preparation. Just mix Freflo with diesel oil or fresh, high-gravity crude, then pump it into the formation. Or, if you wish, Dowell will do the job for you.

Ask for Freflo in 10-gallon steel drums at any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Department G-13.

*Trademark of Dowell Incorporated.

services for the oil industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

"Those who know us best like us best," so—

Let the Public Know!

The public "thinks we are a bunch of rich, overbearing braggarts with a tax gimmick."

These acid words were spoken by a man who should know—Jake L. Hamon, chairman of the American Petroleum Institute. That such a thought should even enter an oil leader's mind, let alone be printed, forms the basis for one of the most glaring paradoxes on the American scene.

The public can hardly deny that it took more—much more than braggarts with a tax gimmick to play a principal role in winning two world wars—to lift this country from mediocrity to unquestioned world leadership—to make American's transportation system, farm productivity, heating methods and production lines the finest in the world.

The public can hardly deny that—within an average life span—men with sheer guts and a willingness to lose everything they owned, transformed oil into a $40 billion industry, second only to agriculture.

Nor can anyone deny that in 1955 the oil industry:

- Was composed mostly of small companies competing sharply with each other.
- Paid more federal taxes than any other industry (nearly $5.5 billion, excluding employe income taxes).
- Averaged less than 10 percent on investment and less than 4 percent net profit, almost exactly the same as for industry as a whole.
- Paid the second highest wages and salaries in the nation.
- Offered employe benefits excelled by few—if any—other industries.
- Had one of the lowest labor turnover records of any industry.
- Had fewer strikes than most industries.
- Topped most industries in contributions to science, technology and education.

Yet at the same time the price of oil and its products has increased so slightly as to be almost indiscernible compared with other commodities.

The public cannot deny any of these true facts—nor can they confirm them. Why?

Because the public doesn't know!

The public doesn't know because the oil industry expends too much of its public relations effort either talking to itself or hiding behind a cloak of righteous conservatism.

The millions of words passed from oil leaders and trade publications to other oil men expounding the need for public relations—the risks oil men take—how outstanding the industry is, creates not one ounce of public understanding or good will for the industry.

The oil industry's conservative "open the door a peek" attitude toward the press, i.e., releases telling about a new wildcat being drilled in some county to attempt to test some formation and that the project is contracted for so many feet in depth, *without the slightest mention of estimated cost*—expansion releases describing new construction in "square feet" *with no mention of estimated cost.* Such actions of intentional omission does not create better understanding of the industry.

No wonder the newspapers and critics yell "propaganda!" when oil attempts to explain its side in a crisis. No wonder the public eats up sensational news stories about the antics of a minute few addle-brained "Johnny come lately" millionaires who plague the industry. No wonder the public thinks of oil in terms of these few "braggarts."

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These are big reasons why the oil industry, although it has done as much or more than any other industry for the American public, can find so few friends when the chips are down. This is the glaring paradox.

This absurd situation can be changed with but little effort. In fact, some—too few—oil companies have already pulled their heads out of the sands of conservatism.

An excellent example is Tidewater Oil's policy of showing the budgeted price for wildcats when they are announced to the press. Another is Imperial Oil's audio-visual program which gives the true facts about the company—and the industry—to each employe.

As Imperial demonstrates, publicity alone will not create public favor. Every employe in the industry must be an *informed* ambassador of good will.

These are examples that might well be followed by the entire industry. But these are not enough, many new examples must be created. Opening all doors to the public and telling oil's story to people outside the industry ranks would be good places to start.

Those who know us best will like us best.

The oil industry has a great story to tell. Let's tell it to the public—to employes—to dealers—to every individual who will listen.

Pemex Director General Antonio J. Bermudez (center) relaxes in the Shamrock Hilton Hotel, Houston, with Alfonso Barnetche (left), manager of Pemex's exploitation department, and Jose Aleman, purchasing agent, during personal interview with WORLD OIL.

A World Oil Interview — *with* — **ANTONIO J. BERMUDEZ**
Director General
Petroleos Mexicanos
Mexico, D. F.

Mexico Steps Up Booming Oil Activity

Important developments include increased discovery rate, major new field, plans for boosting drilling activity, and greater production.

By DON E. LAMBERT
World Oil Staff

Mexico's oil industry is booming. It is indicated that 1956 will be one of the most successful in years.

During the first six months of 1956, Petroleos Mexicanos (Mexico's government oil company) has:

- Discovered 17 new fields, two more than were discovered in all of 1955—the most promising discovery showing initial production of 2520 barrels a day.
- Drilled 181 wells—110 of which were producers.
- Put 124 drilling and workover rigs in operation—and expects to have 34 more in the field by December.
- Just completed a 15,000 barrels a day refinery and has cat crackers under construction at three existing refineries.
- Increased production to 237,000 barrels a day—and daily refining capacity to 325,000 barrels.

These statistics are part of the first comprehensive report on Mexico's fast-growing oil industry to be made in 1956. The report was given to World Oil in an interview with Senator Antonio J. Bermudez, Director General of Pemex.

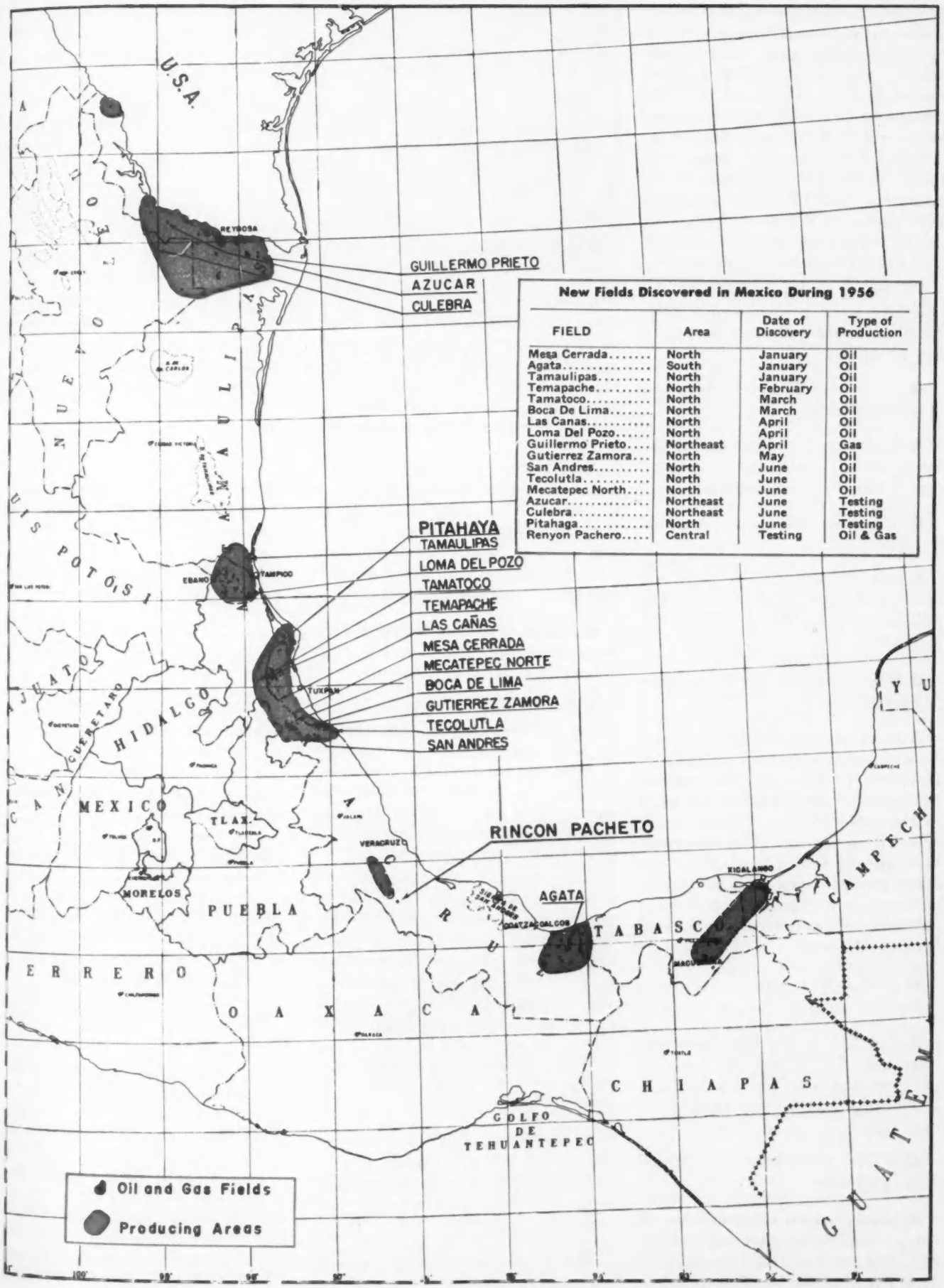
The following interview contains Bermudez' complete report:

Q *Have you found any major fields in recent months?*

A Yes. On June 17 we completed a well in the San Andres field 50 kilometers (about 31 miles) southeast of Poza Rica. Initial production was 2520 barrels of 20.6 gravity crude a day through a 15 millimeter choke, from Checontepec sands, Lower Eocene age. This is the most productive well to be completed in 1956—and it is not a part of the new Golden Lane fields. We have every reason to believe this is a new major field. However, we will soon have four more rigs in the field and they should tell the complete story.

Q *At what depth are you getting*

Where Mexico's New Fields Are Located . . .



New Fields Discovered in Mexico During 1956

FIELD	Area	Date of Discovery	Type of Production
Mesa Cerrada	North	January	Oil
Agata	South	January	Oil
Tamaulipas	North	January	Oil
Temapache	North	February	Oil
Tamatoco	North	March	Oil
Boca De Lima	North	March	Oil
Las Canas	North	April	Oil
Loma Del Pozo	North	April	Oil
Guillermo Prieto	Northeast	April	Gas
Gutierrez Zamora	North	May	Oil
San Andres	North	June	Oil
Tecolutla	North	June	Oil
Mecatepec North	North	June	Oil
Azucar	Northeast	June	Testing
Culebra	Northeast	June	Testing
Pitahaga	North	June	Testing
Renyon Pachero	Central	Testing	Oil & Gas

production from the new discovery?

A From 9350 feet. However, that is a story in itself. During the drilling operations we passed through 650 feet of impregnated sands. Immediately below the sands we drilled into 200 feet of limestone—some of it highly porous—some impregnated with oil. While still in the upper section of the sands at 9100 feet, the casing ruptured. It wasn't able to withstand the pressure of the oil which measured 7400 pounds. We were using 24-pound N-80 casing which is supposed to stand 6000 pounds of pressure.

We still don't know how thick the limestone layer is—but significantly, there was no trace of water in the 200 feet we drilled.

Q *What other discoveries have you made in 1956?*

A As of June 10, we had drilled 181 wells with 110 producers, including 17 new fields (see accompanying map).

Q *What was your discovery record in 1955?*

A During all of last year we brought in only 15 new fields. We drilled 330 wells, 228 of which were producers.

Q *How many rigs does Pemex have in operation?*

A At present we have 90 rigs and 34 workover rigs actually drilling. However, by the end of the year we will have 158 rigs, compared with 120 in December of 1955. Orders for 20 new drilling rigs and 14 workover rigs have already been placed. Some are being erected—some are in Mexico on the way to the fields—and some are being shipped from the United States.

Q *Does Pemex plan to purchase more rigs?*

A Yes. During the last quarter of this year, Pemex will be ready to place another order for 20 more U. S. drilling rigs and perhaps some workover rigs.

Q *Where does Pemex get its oil field equipment?*

A Mexico uses nothing but American equipment, supplies and technology. We attribute our success to a great extent to the fact that we follow the American school of oil technology. We try to stay up to date and copy every new development in the industry.

Q *What is the current production total in the new Golden Lane fields?*

A Discovery of five fields in the new Golden Lane area this year boosted production considerably. These new Golden Lane fields were averaging about 75,000 barrels a day as of June 1.

Q *Has oil consumption increased in Mexico during the past five years?*

A Demand has increased slightly faster than in the U. S.—from 7½ to 10 percent increase in consumption of light products every year since 1951. On the other hand we have had hardly any increase in demand for residual products during the past five years.

As our record shows, Mexico is about the fastest growing country in the world. I feel quite safe in saying that consumption during the next five years is expected to keep pace with the past five years and it possibly will show a greater increase.

Q *Will Mexico's production and refining capacity be able to keep up with this rapid increase in demand?*

A Our production and refining capacity will definitely be able to keep up with demand. Current expansion programs call for enough crude production and refining capacity to take care of all future needs of Mexican consumption and to have sizeable surplus left for export purposes.

At present, our goal for production is 500,000 barrels a day—our current daily average is about 270,000 barrels We are trying our best to achieve this goal as soon as possible. It would not be right to try and set a date, but it won't be long. It is now a matter of more rigs and more drilling of wells.

Q *In working toward your goal, will you adhere to conservation practices?*

A That is one point I want to make very clear. We stick rigidly to conservation practices and we use maximum depletion rate principles in producing our wells.

Q *What are your plans for increasing refinery capacity?*

A Even though our current refining capacity is about 325,000 barrels a day, we admit that we don't have adequate installations to get all the yield from our crudes. We are now exerting considerable effort toward building new cat crackers.

We have just completed a new refinery at Minatitlan with 15,000 barrels a day capacity. Under construction are two 25,000-barrel cat crackers—one at the Mexico City refinery and the other at our Madero refinery. Scheduled for completion in 1957 is a 15,000 barrels a day cat cracker at the Salamanca refinery.

We are building a new lubricating oil plant at Minatitlan to replace the old one which was dismantled—and also to assist in meeting the increased demand for lube oils.

Q *How much oil does Mexico export?*

A We are exporting an average of 80,000 barrels a day, the majority of which is being shipped to the U. S.

Q *How are your efforts progressing to find production on Mexico's west coast?*

A We have drilled nine wells in Lower California to date. We have had only small showings of gas with no commercial value so far. Even so, we have two seismic crews doing geophysical work to assist us in the next location. It is our intention to continue exploration drilling until we find oil on the west coast.

Q *What is the extent of your exploration activity?*

A There are 35 seismic and gravity meter crews, plus 12 surface geology crews operating in various parts of Mexico at present.

Q *Is your natural gas activity keeping pace with oil?*

A Definitely. We are finding sizeable amounts of natural gas in northeast Mexico which are adding considerably to our production and reserves. We are also finding large quantities of natural gas in the State of Tabasco in southeast Mexico. In short, we are increasing our reserves and production of natural gas to a point where they are reaching important figures.

—**The End.**

Using assembly line methods, teams of company officials and clerks processed thousands of legal documents in preparation for final settlement of The Atlantic Refining Company's record-breaking purchase of oil and gas properties from Houston Oil Company of Texas.

Big Deal!

• Hundreds of employes worked five months to help close The Atlantic Refining Company's purchase of Houston Oil Company of Texas.

• $200 million transaction ranks as one of the largest and most complex in the history of oil industry.

ONE OF THE American oil industry's biggest and most complex transactions was closed when The Atlantic Refining Company recently completed acquisition of the oil and gas properties of Houston Oil Company of Texas. The producing and nonproducing properties bought by Atlantic involved an area larger than Rhode Island. For them Houston Oil will net almost $200 million.

Final papers were signed June 6 at Wilmington, Del., in offices of the Corporation Trust Company. The deal was closed exactly five months after first announcement that directors of Houston Oil had voted to liquidate that company.

The brief closing was attended by representatives of all participants in the complicated transaction. It gave no indication of the prodigious amount of negotiation, planning, and legal paper work that was previously required, extending into 10 states.

ELEVENTH HOUR. Surrounded by some of the 2 million pages of legal documents, Henderson Supplee, Jr. (left), president of The Atlantic Refining Company, watches Harold Decker, Houston Oil president, sign a closing paper.

After January 6 about 25,000 copies of deeds and other legal documents connected with the transaction, containing around 2 million pages, were prepared, printed, and processed by several hundred executives, lawyers, notaries, witnesses, and clerks. Transfers of title to more than 6000 separate properties were recorded in some 155 counties in 10 states.

If all of the documents involved in the transaction were stacked in a single pile, it would be almost as high as the Washington Monument. If the separate pages of these documents were laid end-to-end, they would stretch in an unbroken ribbon of paper from Philadelphia to Cleveland, Ohio.

Under terms of the transaction, Atlantic paid to Houston Oil $73.5 million outright. An additional $125 million was paid by a group of investors, of which New York's Chase Manhattan Bank is the principal participant, under a production payment plan. This plan, which is not a financial obligation of Atlantic, stipulates that 85 percent of the oil and gas produced from the acquired properties now producing will be used to satisfy the production payments. It is estimated that the production payments will be completed in about 10 years, at which time all of the production will accrue to Atlantic. Meanwhile, any production developed by Atlantic on those acquired properties which are now undeveloped will not be subject to production payments.

The remaining 15 percent of present oil and gas production will be used by Atlantic to finance the operation of the producing properties. Atlantic has expanded its production organization in the Southwest so that its operation of the acquired properties could begin immediately. A majority of Houston Oil's personnel has joined Atlantic's organization on a permanent basis.

Completing its liquidation June 6, Houston Oil's holdings in East Texas Pulp and Paper Company were sold to Time, Incorporated, which already had a half interest. Houston Oil's timber owning subsidiary, Southwestern Settlement and Development Corporation, was sold to the East Texas Pulp & Paper Company. The

Continued on Page 50

U. S. Firms Have More Foreign Than Domestic Oil Reserves

Domestic and foreign oil reserves of 37 U. S. companies exceed 84 billion barrels. Total oil reserves of all companies within U. S. amount to approximately 35 billion barrels. Five U. S. "international" companies have 65 billion barrels of reserves, or 77 percent of the 84 billion held by 37 companies.

Combined natural gas reserves of 37 companies amount to almost 140 trillion cubic feet. These are mainly in the U. S. They are equivalent to 62 percent of total U. S. gas reserves of almost 224 trillion cubic feet.

FOREIGN FIELDS account for more than one-half the total petroleum reserves held by U. S. oil companies.

This is attested in the table herewith, presenting estimates of domestic and foreign oil and gas reserves of 40 U. S. companies. The table is from the May 17, 1956, Oil Industry Survey of Standard & Poor's Corporation, 345 Hudson Street, New York 14, N. Y.

Total domestic and foreign oil reserves of 37 U. S. companies, according to the table, are over 84 billion barrels. All liquid hydrocarbon reserves in the U. S., for all companies, are only about 35 billion barrels.

Three of the 40 companies in the table are subsidiaries of Standard Oil Company (New Jersey), and the total of 84 billion barrels of reserves includes the parent company but excludes the subsidiaries.

Of the 84 billion barrels of reserves held by 37 U. S. companies, 65 billion barrels or 77 percent are accounted for by five "international" companies. Standard Oil Company (New Jersey) is shown as having 20.5 billion barrels, Gulf Oil Corporation 15.8 billion, The Texas Company 10.8 billion, Standard Oil Company of California 9.5 billion, and Socony Mobil Oil Company 8.4 billion.

Another company shown as holding large foreign reserves is Getty Oil Company, formerly named Pacific Western Oil Corporation. In the table herewith, Getty Oil is credited with a little over 5 billion barrels of reserves. However, this figure appears much less conservative than estimates shown for some other companies. According to a footnote to the table, this figure is "based on an unofficial estimate of probable crude reserves in the Neutral Zone concession (between Kuwait and Saudi Arabia), plus small reserves in the U. S." Getty Oil has a one half undivided interest in the Neutral Zone development area, which in early 1956 was producing about 30,000 barrels daily. In the report of which the table is a part, it is stated that "Proven reserves in the Neutral Zone are put at around 600 million barrels gross. But probable reserves in the concession are unofficially thought to be as much as 5 billion barrels to Getty Oil Company's interest." A footnote to the table explains that "Reserves of various companies are not entirely comparable, as methods and degree of conservatism vary." It appears to WORLD OIL, on the basis of the above facts, that a figure of 300 million barrels for Getty Oil's Middle East reserves might be more closely comparable with the generally conservative data shown for other Middle East operators.

Four other companies have reserves of 1 billion barrels or more each and together they have almost 6 billion barrels. They are: Standard Oil Company (Indiana) 2.1 billion barrels, Phillips Petroleum Company 1.5 billion, Shell Oil Company 1¼ billion and Cities Service Company 1 billion.

The above 10 companies together have 76 billion barrels of oil reserves or 90.5 percent of the 84 billion barrels held by the 37 companies. The remaining 8 billion barrels are held by 27 companies that have less than 1 billion barrels of reserves each.

Among the 27 companies with reserves under 1 billion barrels each, there are eight having ½ to 1 billion barrels each and together holding nearly 5½ billion barrels. They are: Continental Oil Company 900 million barrels, Sun Oil Company 752 million, Amerada Petroleum Corporation 750 million, Sinclair Oil Corporation 712 million, Ohio Oil Company 665 million, Tide Water Oil Company 575 million, The Pure Oil Company 520 million, The Atlantic Refining Company 515 million.

Nine companies are listed as having from 100 million to 500 million barrels of reserves each. They are: Union Oil Company of California 498 million, Superior Oil Company of California 400 million, Sunray Mid-Continent Oil Company 369

million, Skelly Oil Company 351 million, Seaboard Oil Company 210 million, Honolulu Oil Corporation 200 million, Texas Gulf Producing Company 150 million, Texas Pacific Coal & Oil Company 125 million, Hancock Oil Company 120 million.

The table also includes 10 companies with reserves of less than 100 million barrels each. They are: Plymouth Oil Company 90 million barrels, Argo Oil Corporation 90 million, Shamrock Oil & Gas Company 70 million, Monterey Oil Company 69 million, Southern Production Company 62 million, Chicago Corporation 56 million, Anderson-Pritchard Oil Corporation 54 million, Republic Natural Gas Company 40 million, Kerr-McGee Oil 17 million, and Panhandle Oil Company 15 million.

Gas Reserves. Natural gas reserves of the different companies are shown in the table herewith, along with oil reserves. The combined gas reserves of 37 companies are 139.7 trillion cubic feet. These reserves are principally in the U. S. They constitute 62 percent of all U. S. gas reserves of 223.7 trillion cubic feet. Tied in first place among the owners of gas reserves are Standard Oil Company (New Jersey) and Phillips Petroleum Company, with reserves of 20 trillion cubic feet each. Jersey's subsidiary, Humble Oil & Refining Company, has 18 trillion feet. Tied, also, for third and fourth place, are Standard Oil Company (Indiana) and The Texas Company, with gas reserves of 11.5 trillon cubic feet each. Almost tied for fifth, sixth, and seventh place, are: Socony Mobil Oil Company 8.4 trillion, Gulf Oil Corporation 8.2 trillion, and Cities Service Company 8 trillion. Ranking No. 8 is Shell Oil Company with 5.5 trillion feet. Standard Oil Company of California is No. 9 with 4 trillion. Tied for No. 10 and No. 11 positions are Pure Oil Company and Sun Oil Company, with reserves of 3.7 trillion feet each. All other companies listed have less than 3 trillion cubic feet each.

Value of Reserves. Both the gas and oil reserves of each company are evaluated in the table herewith. The value of gas reserves is computed at $0.05 per thousand cubic feet. The value of oil reserves is computed at $1 per barrel for Western Hemi-

Continued on Page 50

Computed Values of Gas and Oil Reserves Vary for Different Companies
(Source: Standard & Poor's Corp's. Oil Industry Survey, May 17, 1956)

Issues—	Gas Reserves		Oil Reserves		Total Computed Value Per Share Gas & Oil Res.	Approx. Price of Shares
	Est. Nat. Gas Res. (Trillion Cu. Ft.)	*Computed Value Gas Reserves Per Share	Est. Oil Reserves (Million Bbls.)	†Computed Value Oil Reserves Per Share		
Amerada Petroleum Corp..	2.5	$20	750	$119	$139	114
Anderson-Prichard.....	[1].2	6	[1]54.4	34	40	36
Argo Oil Corp.....	[2].2	4	[3]90	45	49	36
Atlantic Refining Co.....	[3]2.65	15	[3]515	58	73	44
Chicago Corporation.....	[4]1.52	19	[4]56	14	33	26
Cities Service Co.....	[5]8.0	40	1,000	100	140	69
Continental Oil Co.....	2.8	14	900	92	106	124
Creole Petroleum Corp....	n.e.	..	5,000	63	63	91
Getty Oil Company.....	.03	..	[21]5,028	232	232	50
Gulf Oil Corporation.....	[6]8.2	15	[6]15,800	204	219	127
Hancock Oil Company....	.1	2	120	37	39	39
Honolulu Oil Corp.....	.4	5	200	53	58	67
Humble Oil & Refg. Co....	18.0	25	3,000	83	108	124
International Pet. Corp....	n.e.	..	[7]335.4	23	23	38
Kerr-McGee Oil Ind., Inc..	[8]0.8	22	[8]17	10	32	50
Monterey Oil Company...	[9]0.05	2	[9]69	43	45	35
Ohio Oil Company.....	[10]2.11	8	[10]665.5	51	59	43
Panhandle Oil Company...	[1].05	2	[1]15	9	[22]11	14
Phillips Petroleum Co.....	[11]20.0	58	[11]1,500	88	146	104
Plymouth Oil Company...	1.5	31	90	37	68	37
Pure Oil Company.....	3.7	22	520	61	83	50
Republic Natural Gas Co..	2.5	42	40	13	55	28
Seaboard Oil Company....	.7	9	210	57	66	62
Shamrock Oil & Gas Co...	1.7	37	70	30	67	54
Shell Oil Company.....	5.5	10	[12]1,250	46	56	85
Sinclair Oil Corp.....	[13]1.9	6	[13]712	50	56	71
Skelly Oil Company.....	[14]2.3	20	[14]351	62	82	66
Socony Mobil Oil Co.....	[15]8.4	12	[15]8,420	100	112	79
Southern Production Co...	[16]1.166	34	[16]62	36	70	43
Standard Oil Co. of Calif..	4.0	3	[17]9,500	56	59	57
Standard Oil Co. (Ind.)...	[18]11.5	18	[18]2,097	65	83	62
Standard Oil Co. (N.J.)...	20.0	5	[19]20,520	63	68	60
Sun Oil Company.....	[20]3.7	18	[20]752	75	93	78
Sunray Mid-Continent....	1.9	6	369	22	28	27
Superior Oil Company.....	2.8	350	400	950	1,300	1,085
Texas Company.....	11.5	10	10,800	87	97	67
Texas Gulf Producing Co..	.4	5	150	41	46	46
Texas Pacific Coal & Oil..	.5	7	125	35	42	39
Tide Water Oil Company..	2.5	10	575	46	56	45
Union Oil Co. of Calif.....	1.9	13	498	68	81	61
[23] Total 37 Companies...	139.676	..	84,290.9	....	....	....

Note: Reserves of various companies are not entirely comparable as methods and degree of conservatism vary. * Computed at $0.05 per M Cubic feet. † Computed at $1 per barrel for Western Hemisphere crude and $0.25 per barrel for Eastern Hemisphere crude. [1] Official estimate Jan. 1, 1956. [2] Official estimate 1954. [3] Official estimate Dec. 31, 1955. [4] Official estimate Jan. 1, 1955. [5] Excludes gas purchased under long term contracts. [6] Official estimate October 31, 1955; includes 4.2 trillion gas outside U.S.; also 13.8 billion barrels crude in Kuwait, and 690 million barrels in Canada and Venezuela. [7] Official estimate Jan. 1, 1953. [8] Official estimate April 1, 1955. [9] Official estimate August 31, 1955. [10] Official estimate Sept. 30, 1955. [11] Unofficial, 1956. [12] Official, Jan. 1, 1955. [13] Official estimate Jan. 1, 1954, plus American Republics 34 million barrels, and 178 billion cubic feet gas. [14] Engineers' estimate Jan. 1, 1953. [15] Official, Dec. 31, 1955; includes about 1.92 billion gross U.S. with only a minor part of offshore; about 6.5 billion Eastern Hemisphere. [16] Official, Dec. 31, 1954. [17] Including about 8 billion Eastern Hemisphere. [18] Official, net reserves, Dec. 23, 1955: practically all in U.S. [19] Official estimate Dec. 31, 1953; includes 3.26 billion U.S., 6.22 billion other Western Hemisphere and 11.04 billion Eastern Hemisphere. Market value of four major holdings (Creole, Humble Oil, Imperial Oil, International Petroleum) approximates $60 per Jersey share. [20] Official estimate Dec. 31, 1955, practically all U.S. [21] Based on unofficial estimate of probable crude reserves in Neutral Zone concession, plus small reserves in U.S., valued around $5 per share. n.e. No estimate attempted. [22] Before sale of 600,000 shares to American Petrofina. [23] Includes Standard (N.J.); excludes that Company's subsidiaries, Creole, Humble, International Petroleum Corporation.

Fluid Injection Expands U. S. Oil Resources

• Reserves now economically recoverable by fluid injection amount to 12 billion barrels.

• By producing them, the country henceforth will obtain from presently known fields 40.4% more oil than 29.7 billion barrels recoverable by primary methods.

By L. J. LOGAN
WORLD OIL Staff

WITH THE BENEFIT of fluid injection methods, presently known U. S. oil fields henceforth will give up 40.4 percent more oil than would be recovered by primary methods.

U. S. reserves recoverable by primary production and fluid injection methods under existing economic conditions amounted to 41,649,000,000 barrels as of January 1, 1956. Of this total, 29,670,000,000 barrels or 71.2 percent represented primary reserves, and 11,979,000,000 barrels or 28.8 percent consisted of fluid injection reserves producible under prevailing economic conditions.

These estimates have been made by the Secondary Recovery and Pressure Maintenance Committee of the Interstate Oil Compact Commission. Chairman of the committee is Paul D. Torrey. The report was presented to the Compact Commission at Dallas June 2.

Recovery of 32.7% Assured. The oil fields of the U. S. had produced 52,687,000,000 barrels up to January 1, 1956, the report showed. Adding to that past production the combined primary and fluid injection reserves of 41,649,000,000 barrels indicates that the presently known oil fields of the U. S. probably will produce eventually 94,336,000,000 barrels of oil. That amount would be 32.7 percent of the estimated 288,523,000,000 barrels of oil originally contained in the reservoirs.

"Although this percentage of recovery is much less than that obtained by certain other mineral industries," said the committee, "it represents a great improvement over the

U. S. Oil Resources January 1, 1956, Include 12.0 Billion Barrels of Economically Recoverable Fluid Injection Reserves and 29.7 Billion Barrels of Primary Reserves.

Source: Secondary Recovery and Pressure Maintenance Committee of Interstate Oil Compact Commission.

Millions of Barrels

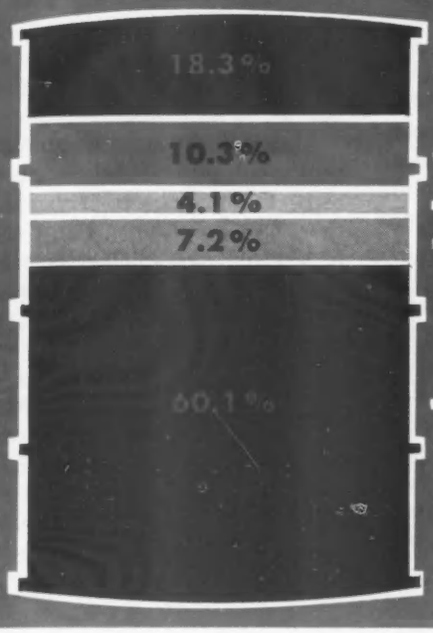
STATE	Orig. Oil Content in Reservoirs (1)	Total Oil Prod. to Jan. 1, 1956 (2)	Oil Still in Reservoirs Jan. 1, 1956 (3)	Proved Oil Reserves Jan. 1, 1956, API Basis (4)	Primary Reserves Jan. 1, 1956, IOCC Basis (5)	Maximum Fluid Injection Reserves (6)	Fluid Injec. Reserves, 1-1-56 Eco. Conditions (7)	Presently Recoverable Reserves (Cols. 5+7) (8)	1955 Oil Production (9)	% of Reserves Produced in 1955 (10)	Ultimate Prod. Jan. 1, 1956 Eco. Conditions (11)	% of Orig. Oil to be Produced (12)	Presently Unrecoverable Oil (Cols. 1-11) (13)	% of Orig. Oil Not Recoverable (14)
New York	743	196	547	43	0	69	58	58	3	5.2	254	34.2	489	65.8
Pennsylvania	3,831	1,199	2,632	93	0	787	93	93	9	9.7	1,292	33.7	2,539	66.3
West Virginia	2,574	454	2,120	47	53	598	60	113	3	2.6	567	22.0	2,007	78.0
Kentucky	1,600	317	1,283	107	103	400	57	160	16	10.0	477	29.8	1,123	70.2
Ohio	4,450	639	3,811	56	53	175	11	64	4	6.2	703	15.8	3,747	84.2
Indiana	1,575	259	1,316	61	50	275	75	125	11	8.8	384	24.4	1,191	75.6
Illinois	7,000	1,837	5,163	691	400	3,000	1,500	1,900	82	4.3	3,737	53.4	3,263	46.6
Michigan	1,390	385	1,005	59	56	265	93	149	11	7.4	534	38.4	856	61.6
Kansas	14,075	2,708	11,367	998	900	350	125	1,025	120	11.7	3,733	26.5	10,342	73.5
Oklahoma	46,200	7,199	39,001	2,016	1,600	1,500	650	2,250	201	8.9	9,449	20.4	36,751	79.5
Arkansas	2,633	937	1,696	330	168	1,334	1,174	1,342	26	1.9	2,279	86.6	354	13.4
Mississippi	3,026	466	2,560	388	385	1,040	78	463	36	7.8	929	30.7	2,097	69.3
Louisiana	19,578	3,765	15,813	3,255*	3,367	4,307	1,938	5,305	245	4.6	9,070	46.3	10,508	53.7
Texas	99,850	18,923	80,927	14,934*	15,606	11,498	4,982	20,588	1,022	5.0	39,511	39.6	60,339	60.4
North Dakota	930	20	910	186	186	60	10	196	11	5.6	216	23.2	714	76.8
New Mexico	6,500	1,012	5,488	820	870	1,800	92	962	81	8.4	1,974	30.4	4,526	69.6
Colorado	3,047	342	2,705	334	300	600	100	400	53	13.2	742	24.4	2,305	75.6
Wyoming	10,100	1,326	8,774	1,374	1,300	975	290	1,590	99	6.2	2,916	28.9	7,184	71.1
Montana	2,248	227	2,021	300	353	117	29	382	15	3.9	609	27.1	1,639	72.9
California	56,800	10,410	46,390	3,801*	3,801*	3,600	529‡	4,330	355	8.2	14,740	26.0	42,060	74.0
Other States†	373	66	307	119	119	80	35	154	16	10.4	220	60.0	153	41.0
Total	288,523	52,687	235,836	30,012	29,670	32,830	11,979	41,649	2,419	5.8	94,336	32.7	194,187	67.3
Change from 1-1-54	+16,590	+4,870	+107‡	+1,067	+1,884	+3,693	+452	.....	....	.....	.....	.....	.....	....

Identification of Columns:
1. Estimation of original oil content of reservoirs. 2. Total oil production to Jan. 1, 1956. 3. Total oil in reservoirs Jan. 1, 1956 (Column 1 less Column 2) 4. Proved reserves from API new release, March 15, 1956. 5. Primary reserves as of January 1, 1956. (Estimate of Interstate Oil Compact Commission.) 6. Estimation of maximum recovery obtainable by application of fluid injection methods. (Estimate of Interstate Oil Compact Commission.) 7. Estimation of recovery from fluid injection under Economic Conditions Existing as of Jan. 1, 1956. (Estimate of Interstate Oil Compact Commission.) 8. Combined primary and fluid injection reserves (Column 5+7). 9. 1955 oil production. 10. Percent of reserves produced in 1955. (Column 9 as Percent of Column 8.) 11. Ultimate production from known fields under Jan. 1, 1956, Economic conditions (Column 2+8). 12. Percent of original oil content to be produced ultimately (Column 11 as percent of Column 1.) 13. Oil not to be recovered under existing conditions (Column 1 less Column 11.) 14. Percent of original oil content to be unrecovered (Column 13 as percent of Column 1).

Footnotes:
* Includes off-shore reserves. † Includes Alabama, Arizona, Florida, Missouri, Nebraska, Nevada, South Dakota, Tennessee, Utah, and Virginia.
‡ From National Stripper Well Survey, January 1, 1955. ‡ Change from 1953 to 1955 production.

Fluid Injection Reserves Important Part of U. S. Oil Resources

288.5 billion barrels of oil originally in reservoirs include:



- 52.7 billion barrels already produced.
- 29.7 billion barrels primary reserves
- 12.0 billion barrels fluid injection reserves.
- 20.8 billion barrels fluid injection reserves not now economically recoverable.
- 173.3 billion barrels unrecoverable by present methods.

One-Third of Oil Originally in U. S. Reservoirs Will Be Recovered

Remainder is unrecoverable by present methods. But it offers the industry a great challenge. Ways to recover some of it may be found in the future.

INJECTION ADDS 40.4% TO RESERVES	Reserves of 12.0 billion barrels are now economically recoverable by fluid injection. They increase by 40.4% the reserves of 29.7 billion barrels producible by primary recovery.
RECOVERY OF 32.7% ASSURED	These presently recoverable reserves will add to the 52.7 billion barrels already produced. Thus 94.4 billion barrels, or 32.7% of the 288.5 billion barrels of oil originally contained in the reservoirs, will be recovered.
AT PRESENT UNRECOVERABLE	Of the 288.5 billion barrels originally in place, 194.1 billion barrels, or 67.3%, are at present unrecoverable. This vast amount of oil, locked in the ground, and defying extraction, offers the industry a tantalizing challenge.
POSSIBLE TO RECOVER	It would be possible, though not now economically feasible, to recover an additional 20.8 billion barrels of oil by fluid injection. Such production would boost ultimate recovery to 115.2 billion barrels, or 39.9% of the oil originally present.
WHOLLY OUT OF REACH	Unrecoverable by present methods are 173.3 billion barrels of oil, or 60.1% of the oil originally in the reservoirs. This huge amount is now wholly out of reach. But new methods and future economic conditions might make some of it recoverable.

recovery that was obtained from oil fields only a few decades ago."

The improvement in recovery is due in large measure to the adoption of conservation practices by most of the states, according to the committee, and to new production techniques.

It can be foreseen, the committee added, that a greater recovery of the nation's oil resources will be obtained in the future than has been the case in the past.

Challenge Presented. Nevertheless, it is indicated that the vast amount of 194,187,000,000 barrels of oil, or 67.3 percent of the original oil in place, will not be recovered under presently existing economic conditions. This huge amount of presently unrecoverable oil presents a challenging problem, the committee declared. It is a challenge, said the report, from the standpoint of the tremendous energy potential involved, for the security of the nation, and because the production of oil contributes so much to the maintenance of government and to the comfort and welfare of the people.

While the committee estimated that 11,979,000,000 barrels of oil are recoverable by fluid injection under present economic conditions, it indicated that it would be possible to recover an additional 20,851,000,000 barrels by fluid injection. For maximum fluid injection reserves were estimated at 32,830,000,000 barrels.

Some Oil Unrecoverable. "There are well known irreducible minimums beyond which oil cannot be extracted from its containing reservoirs," the report pointed out, "similar to the fact that certain amounts of coal cannot be removed from underground mines.

"Thus it would be a reasonable guess that there is no known way to recover some 58 billion barrels of the original content of the nation's reservoirs. Also, the recovery of large quantities of oil that remains may not be feasible for geologic reasons and certainly will be dependent on economic conditions in future years."

It is already known, the committee said, that almost three times as much oil is susceptible to recovery by fluid injection (32,830,000,000 barrels) as the amount that can be extracted profitably by these methods under present conditions (11,979,000,000 barrels). "Although the recovery of much of this oil is certainly problematical at this time, knowledge of its existence is important."

Important For Future. The important part that fluid injection will have in future oil production in various states is very apparent from the table herewith. The primary reserves of New York and Pennsylvania are considered to be negligible. In Illinois oil reserves that can be obtained by fluid injection are almost four times the primary reserves. In Arkansas the ratio is even higher.

"It can be seen from the table," stated the committee, "that the recoverable oil reserves of the nation, as a result of the development of fluid injection methods, are in the range of some 42 billion barrels rather than around 30 billion barrels, as has been estimated by others. This amounts to a very significant increase of about 40 percent."

Previous Report. The Secondary Recovery and Pressure Maintenance Committee submitted its first report on the oil resources of the U. S. at the 1955 mid-year meeting of the Compact. That report was based on conditions as they existed at the beginning of 1954. That was probably the first attempt that had ever been made to determine the amount of oil that existed originally in the underground reservoirs of the fields of the U. S. and to estimate on a national basis the amount of additional oil that could be obtained by application of fluid injection methods.

As in the initial report, the presently estimated primary reserves are slightly smaller than the estimation by the American Petroleum Institute. However, if the Compact Committee's primary reserves are added to its economically recoverable fluid injection reserves, the sum is considerably greater than the API proved reserves. The fact that the findings of the two committees are not in agreement is not surprising. The Compact Committee takes the optimistic view that results in hundreds of fluid injection operations are sufficiently dependable to be used as a criterion for estimation of possible additional recovery. There are fluid injection operations in almost all oil producing states, and some of the fields involved afford historical records of 35 years of continuous operation.

Sources Well Qualified. Most of the persons who contributed to the Compact Commission survey were selected by the governors of the oil producing states as being well qualified authorities. They include geologists and engineers connected with the state geological surveys and oil and gas conservation commissions, boards, or agencies.

Many of the state committees and geological surveys believe that their respective primary reserves are higher than API estimates. "This is a matter of opinion," stated the Compact committee report, "and certainly need not be cause for contention. For it is well known that the API Reserves Committee periodically has revised and increased its estimations of proved reserves as new fields have been discovered, as the area of known fields has been expanded, or as deeper reservoirs have been found in older fields."

Use of Reserves in 1955. The manner in which the respective states utilized their oil resources in 1955 is shown in the accompanying table in Columns 9 and 10. "These figures are not presented for the purpose of criticism of any particular state's policy," the report stated. "They are revealing, however, in that they show that the life of the oil industry is certainly going to be extended in states where maximum recovery by fluid injection methods has been encouraged by wise conservation laws and by the initiative of the industry.

"Of course, much more oil is going to be found in the future in most of the states. But this oil is going to be progressively more difficult to find and certainly more expensive to find. As a result, the U. S. in the future is going to have to place increasing reliance on oil that has already been found, on imports of hydrocarbon liquids, and on other sources of energy.

Fluid Injection Significant. "The phenomenal growth in the production of oil from fluid injection projects in post World War II years is the best evidence that can be presented on the significance of these operations," the report concluded. "In fact, outside of the actual discovery of oil reserves, the development and application of fluid injection techniques certainly ranks as the most important single factor in the maintenance of the oil industry in many of the states."

—The End

Oil Industry Stocks Popular With Investment Companies

NAIC members have invested almost 12 percent of their assets in 136 oil companies.

WIDESPREAD CONFIDENCE in the future of the petroleum industry and of oil companies is reflected in the popularity of oil firm stocks among investment companies.

Holdings of oil stocks by investment companies are now worth more than $1 billion, according to the National Association of Investment Companies. Total value of oil stocks held by all 152 members of the association recently was $1,178,924,000.

Oil producers, refiners, and distributors, as well as integrated companies are represented in the holdings. Stocks of 136 different oil companies are owned by NAIC members. The oil stocks account for almost 12 percent of the total assets of all NAIC members.

Interest of the investment companies in the oil industry has been stimulated by the growth of the oil companies. Total assets of U. S. oil companies have increased every year since 1945. They rose from $21.5 billion in 1945 to $47.2 billion in 1954, a gain of over 100 percent.

Standard Oil Company (New Jersey) has attracted more investment company money than any other oil company, a total of $122,577,000. "Jersey" is held by 80 investment companies, the greatest number holding any security in any industry.

The second largest investment of the investment companies in the oil industry is that of $89,600,000 in Amerada Petroleum Corporation. However, stocks of nine other companies are held by more investment companies than the 29 holding Amerada.

Listed in a table herewith are the 20 largest oil company holdings of the investment companies. The different oil companies are listed and ranked according to the dollar value of their shares held by the investment companies. The table also shows the number of investment companies holding securities of each of the 20 oil companies listed.

Ranked according to value of their stocks held by the investment companies, the 18 leading companies in addition to "Jersey" and Amerada are: The Texas Company, Standard Oil Company of California, Continental Oil Company, Gulf Oil Corporation, Socony Mobil Oil Company, Shell Oil Company, Sinclair Oil Corporation, Phillips Petroleum Company, Superior Oil Company of California, Louisiana Land & Exploration Company, Standard Oil Company (Indiana), Texas Pacific Coal & Oil Company, Cities Service Company, Seaboard Oil Company, Ohio Oil Company, Royal Dutch Petroleum Company, Sunray Mid-Continent Oil Company, and Skelly Oil Company.

—The End

Investment Company Holdings of Oil Stocks

Total Number of Stocks Held	136
Total Dollar Value of All Oil Stocks Held	$1,178,924,000
Percent of Total Assets 3-31-56	11.91%

20 Largest Holdings:

COMPANY	Number of Investment Companies Holding	Dollar Value of Shares Held (000 Omitted)
1. Standard Oil (N.J.)	80	$122,577
2. Amerada Petroleum	29	89,600
3. The Texas Company	49	86,229
4. Standard Oil (Calif.)	57	76,167
5. Continental Oil	46	67,235
6. Gulf Oil	42	53,952
7. Socony Mobil Oil	57	46,377
8. Shell Oil Company	41	44,954
9. Sinclair Oil	40	42,973
10. Phillips Petroleum	50	41,175
11. Superior Oil of Calif.	14	39,507
12. Louisiana Land & Exploration	24	36,505
13. Standard Oil (Ind.)	28	31,452
14. Texas Pac. Coal & Oil	15	31,415
15. Cities Service	23	29,856
16. Seaboard Oil	16	24,102
17. Ohio Oil Company	25	21,803
18. Royal Dutch Pet.	26	23,761
19. Sunray Mid-Cont. Oil	21	23,656
20. Skelly Oil	20	18,977
Total 20 Stocks	..	$952,273

Note:—All statistics from latest financial reports of member companies.

California Drilling Decline Blamed on Price of Crude

A SIGNIFICANT falling-off in drilling activity and development of proved crude reserves in California is being caused by failure of the crude price structure to keep pace with steadily mounting costs. This claim was made in an analysis prepared recently by Oil Producers Agency of California.

The report compared the state's 1953 drilling with present activity. It showed that during the first two months of 1953 there were 247 wells actively drilling, and for the entire year the monthly average was 253 wells. In contrast, the analysis revealed that during the first two months of this year there was an average of only 185 drilling wells. That was a decrease for the two months of 25 percent from the like 1953 period and 27 percent from the average for all of 1953.

Crude reserves in the state at the end of 1952 were roundly, 3.85 billion barrels. At the end of 1953, in spite of an all-time high daily average production for that year of one million barrels, reserves reached 3.92 billion barrels. By the end of 1954 reserves had dropped to 3.89 billion barrels, and by year-end 1955 to 3.8 billion barrels. This decline of about 100 million barrels since the end of 1953, the agency points out, comes in the face of increasing requirements.

In a letter to its membership on May 29 of this year, the agency cites, as further evidence of failure of crude prices to keep pace with rising costs, the just-issued 1955 report of the State Franchise Board. That report, covering the year 1954, states that out of 896 state tax returns filed by oil producing corporations, only 382, or 42.6 percent of them, reported a profit. These figures are compared with 1953 returns, which showed that out of 893 returns, 396, or 44.3 percent, reported a profit.

This percentage change and drop in the number of profit-making companies may not be of large magnitude, the agency says, but it does indicate that the oil producing industry in the state is losing ground. The agency report emphasizes, further, that the most recent Franchise Tax Board report covers only through 1954; that, with constantly increasing costs during 1955, and only a fractional increase in the average price of crude during the year, "all signs point to an increased deterioration in the producer's position."

—The End.

BIG DEAL!

Continued from Page 43

purchase price of these properties was approximately $35 million.

Houston Oil planned to make a first liquidation payment of $162 a share to its stockholders June 7 and a final payment of approximately $4 per share in a few months.

As a result of the Houston transaction, Atlantic has acquired the following assets:

1. All reserves of crude oil and gas that will remain after the production payment is satisfied. It is estimated that at that time approximately one-half of the presently known reserves will remain. These proved underground reserves include about 77.5 million net barrels of crude oil, crude condensate and plant product reserves, and about 978 billion cubic feet of net proved gas reserves.

2. A total of 473 net oil wells and 133 net gas wells producing on the Houston Oil properties.

3. A total of almost 83,000 net acres of oil and gas producing properties.

4. Approximately 877,000 acres of non-producing mineral properties, consisting of 473,000 net lease acres, and 404,000 net fee or mineral fee acres.

5. Other assets used by Houston Oil in its production operations.

6. Stock of the Houston Pipe Line Company, a wholly-owned subsidiary of the Houston Oil Company, which owns and operates a gas pipe line system consisting of about 761 miles of transmission lines and 408 miles of gathering and distribution lines, all located in Texas. The capacity for this transmission system is approximately 375 million cubic feet daily, and deliveries last year were at an average of almost 300 million cubic feet daily.

Atlantic is an integrated company and one of the oldest in the American oil industry, having been chartered in 1870. The company's headquarters are in Philadelphia, and it markets products in 17 states along the Eastern Seaboard and in Brazil. The deal with Houston Oil is an important step in the company's continuing program to increase its crude production, which at present is about 52 percent of refinery requirements.

—The End

OIL RESERVES

Continued from Page 45

sphere crude and $0.25 per barrel for Eastern Hemisphere crude.

For an oil company, the value of its reserves naturally has an important influence on the market price of its capital stock. In the accompanying table, the computed value of gas and oil reserves per share for each company is compared with the approximate price of the company's stock per share.

For 9 of the 40 companies included in the table, their stocks recently were selling for prices exceeding the computed value of their gas and oil reserves. They were: Continental Oil Company, the three Standard of New Jersey subsidiaries, Creole Petroleum Corporation, Humble Oil & Refining Company, and International Petroleum Corporation; Honolulu Oil Corporation, Kerr-McGee Oil Industries, Inc., Panhandle Oil Company, Shell Oil Company, and Sinclair Oil Corporation. Stocks of these companies sell for more than the computed value of their reserves for several reasons, apparently. Investors evidently place importance on such factors as the refining, marketing, chemical manufacturing, pipe line, and other properties and operations of these companies, their capable managements, and their progressive policies, as well as the substantial oil and gas reserves they hold.

The stocks of seven companies recently were selling for approximately the same amounts as the computed value of their gas and oil reserves. They were: Hancock Oil Company, Anderson-Prichard Oil Corporation, Seaboard Oil Company, Standard Oil Company of California, Sunray Mid-Continent Oil Company, Texas Gulf Producing Company, and Texas Pacific Coal & Oil Company. In this group are several integrated companies, with profitable refining and marketing operations in addition to ample oil and gas reserves. Also included are several producing companies, whose stocks are attractive particularly because of their reserves.

For each of the remaining 24 companies, the computed value per share for gas and oil reserves held is greater than the recent market price of the stock of the company. The excess of the value of reserves over price of stock is only several dollars for some companies. But for a number of companies the computed value of reserves is 25 to 50 percent more than the stock sells for. For several companies, indicated value of reserves is around twice the market price of the stock. In this group are international, domestic integrated, and producing companies. The 24 companies constitute, in fact, a majority of the 40 companies included in the table. They include international companies: Standard Oil Company (New Jersey), Gulf Oil Corporation, The Texas Company, Socony Mobil Oil Company; Getty Oil Company; integrated companies: The Atlantic Refining Company, Cities Service Company, The Ohio Oil Company, Phillips Petroleum Company, Plymouth Oil Company, The Pure Oil Company, Skelly Oil Company, Standard Oil Company (Indiana), Sun Oil Company, Tide Water Oil Company, Union Oil Company of California; producing companies: Amerada Petroleum Corporation, Argo Oil Corporation, Chicago Corporation, Monterey Oil Company, Southern Production Company, Superior Oil Company of California; important gas producing companies: Republic Natural Gas Company and Shamrock Oil & Gas Company.

Oil and gas reserves have become increasingly important to companies in the petroleum industry of the U. S. The value of proved reserves is greater now than formerly because the cost of finding and developing petroleum has increased sharply in recent years. (WORLD OIL, June 1956, pages 90-96.) **—The End**

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What Are We Doing About Middle Men of Management?

Here is a revealing study of modern industry's executive manpower problem. Many of these excellent suggestions for improving a management development program may fit into your operation.

By JOSEPH M. TRICKETT
Coordinator, Management Development Food Machinery & Chemical Corporation
San Jose, California

MIDDLE MANAGEMENT is an important area of modern industry—and in it are likely to be found the "forgotten men" of management.

These men are neither chief executives of their organizations, nor are they currently in front-line management or supervision. Yet they constitute a pool from which industry must recruit its top flight executives.

In its accelerated effort to find executives, modern industry must depend on management development. In turn, management development depends upon middle management in a more or less logical pattern. To follow this evolution in the thinking of modern management, three related questions must be reviewed:

1. Why is management development of increasing and vital importance in American business?
2. What is the role of middle management in a company's management development?
3. How is personal development involved in management development?

Why Management Development? It is no accident that, during the past few years, most of the well-known companies in America have become interested in management or executive development. In fact, over 75 per cent of all large companies in

To be successful, management development *must* be based on a sound philosophy. If you can answer "yes" to these seven questions your development program has every chance for success . . .

Do you have:

1. **A broad statement of policy to crystallize the philosophy and synthesize the determined objectives?**
2. **Some procedures and "tools" to implement this policy?**
3. **Participation by top line management?**
4. **Provision for application within the entire management team?**
5. **Identification of available management development resources?**
6. **Almost unlimited subject matter coverage?**
7. **Provision for continuous, long-term "action," with feed-back controls to assure such continuity?**

the country have some formal approach to the development of their executive material. About three-fourths of these have had management development programs for no longer than seven years.

Several factors have combined to bring about this new interest in executive growth and development. First, there is the changing picture in business itself. The job of management in business today is markedly different from what it was 15 years ago.

Throughout industry of all types and sizes, within all functions in business, there are new demands upon managerial skill and ability. The very impact of a new and fast-changing technology, the changes in the marketing and distribution picture, and the highly dynamic and volatile human relations problems are familiar. And these are only the beginning. As Peter Drucker has pointed out in his challenging look at *The Next Twenty Years*:

"The greatest educational need may well be in management . . . the "intuitive" manager is obsolete; and "experience" will not be a very reliable guide . . . indeed it would be hard to find an institution of learning where he could acquire today the education he needs to be a manager tomorrow. But, in the sense of being able to handle systematic knowledge, he will have to be highly educated.

"This educational job will have to be done, to a very large extent, in and by the business itself . . ."

The second fundamental change within American industry which has emphasized the need for developmental activities is the transition from a proprietary-to a professional-management group.

One qualified observer, Robert McMurry, points out that this change began right after World War I and is continuing through the present. He says that the problem of finding and developing qualified, professional managers is a fairly new one; that until World War I, there was relatively little need for managers of this kind since most businesses were managed by their owners.

The trend during the past 25 years toward the separation of ownership from management, plus the increasing complexity and size of business operations, has fostered the growth of the professional manager. Not only does this new professional manager know that he must be particularly and specifically trained to handle what he calls his *"trusteeship responsibilities,"* but he knows that he has a continuing and pressing responsibility to keep up in his chosen profession.

There is a third related factor in this new interest in executive growth —it has even been likened to a managerial renaissance. A few years ago, several qualified observers, among others, pointed a change in the outlook, in the attitude, of existing managers. This is generally shown by a new willingness to learn, a new recognition of room for personal growth and improvement, a seeking of methods to improve one's personal efficiency and effectiveness.

The phenomenal growth in variety and number of management programs in colleges and universities throughout the country, overwhelming demands for enrollments in seminars and programs of such organizations as the AMA and the N.I.C.B., and the great increase in demand for management literature of all sorts are symptomatic of this new interest, of the managerial enlightenment.

What is Management Development? Any discussion of the importance of management development today requires some definition of terms, for, like most of the terminology of modern business administration, there is a great deal of confusion and even contradiction.

In the minds of many, management development means something to be done today to young and inexperienced men to make them qualified to assume managerial responsibilities tomorrow.

To others, management development means "sending two men each year to Harvard" or some other such university program.

To a few, the term means replacement charts, age-of-incumbent analyses, manning tables for the very top positions in the company hierarchy. And to some it means the training classes, outside written material sent to individuals, or other efforts to improve quality of company foremanship or supervision.

Management development, of course, means all of these things.

Management development is a continuous process or activity which is concerned with selection, organization, maintenance and improvement of management personnel throughout the organization. As such, it is a threefold responsibility—of each individual, for his self-development; of each boss, for the development of his subordinates; of the company as a whole, to provide each boss with adequate tools, procedures and guidance.

Objectives and Philosophy. It has been pointed out again and again, by many recognized management authorities, that effective management development is more a philisophy of management that it is a system of forms and procedures. Yet many companies seem to have adopted and adapted the trappings without formulating, accepting, and internalizing the necessary philosophy. Likewise, many companies, which have attempted to do something formal about the development of their management personnel, have failed to define or even think through the objectives of whatever they are setting out to do.

A great many even formally-defined and stated objectives or purposes of executive development activities are inadequate or severely limited in scope. A little time spent in clarifying such objectives and in making them generally known throughout the organization would be well justified by larger returns from such activities.

Putting the Philosophy to Work. Even well-crystallized beliefs and stated objectives will not, in themselves, provide a sufficient guide for all managers at all levels and all locations—there must be some means to put the philosophy to work. Therefore the following steps or phases of putting an effective management development philosophy to work within the organization are proposed:

1. A broad statement of policy to crystallize the philosophy and synthesize determined objectives.

2. Certain procedures and tools to implement this policy. Three basic tools are of prime importance: an individual experience record; a performance appraisal or review procedure; and a specific plan or program for each individual.

3. Participation by top management.

4. Provision for application within the entire management team.

5. Identification and use of available management-development resources.

6. Almost unlimited subject-matter coverage.

7. Provision for continuous, long-term action, with feed-back controls to assure such continuity.

The Role of Middle Management. During the last few years, much concerning top management and front-line or supervisory management has been heard and read. Very little has been written or spoken about the several levels or layers of management responsibility which lie between top, general company management and management at the work level.

Middle management can best be defined by exclusion—by excluding those few individuals who have inter-functional, company-wide responsibilities and those who have immediate and direct supervision of work being done at any location or within any function.

This leaves the individuals involved in the several levels of management who, in most companies, are responsible for particular functions, locations, facilities, or products (things).

The "forgotten men" in management. A few years ago it was quite fashionable to refer to the foreman, the first-line supervisor, as "the forgotten man" in management, but since that time a variety of foreman training activities has developed.

In a relatively minor number of instances, companies have begun to recognize that more is needed in developing an effective organization than foreman or supervisory training. Frequently, the chief things wrong with the foremen's attitudes and behavior were the foremen's foremen—middle management.

The diminution of real authority at the working level and the creation of a wide variety of staff experts have served to augment the fact that individuals in management who actually may need broadening, horizon-clarifying attention most are many of those in middle management.

For example, most progressive companies have given some consideration to the way the over-all organization structure of the company is set up, its basic divisional and departmental setup. Likewise, there has been frequent analysis and attention to areas of responsibility and lines of authority at the work level—usually dictated by the nature of the work processes.

There has, however, been relatively little attention to the problems of organization planning within the several levels of responsibility which here are called middle management. A part of this neglect is reflected in the lack of developmental activities which are carried on within this group. This runs the gamut from membership in professional societies and attendance at management meetings (well-used by members of top management) to specific developmental and improvement classes for supervisors (most frequent at the lowest level). Yet, management development cannot be genuinely effective within an organization unless the essential interlocutory role of middle management is recognized and utilized.

Of course the developmental role cannot effectively be played either up or down, unless executives are willing first to look to their own development.

Dr. Ohmann of the Standard Oil Company of Ohio and one of the country's authorities in this field of personal development has put this point succinctly: "... emphasis in ... training has usually been on training the other fellow—his needs and shortcomings being more apparent than our own . . . Let's start management development with ourselves. Certainly, we have some responsibility for developing others, but I sometimes think we could accomplish more if we just worked on ourselves."

Personal Development. Earlier it was emphasized that management development is man development and that each man, each individual, must want to develop. Actually, it is almost a phycho-physical truism that growth and development of an individual must continue; when growth process and growth desire stop, de-

Leadership begins with the individual. Here are six excellent keys to self-managerial development . . .

1. **Begin now to recognize and keep up with the latest developments in your chosen profession of management.**
2. **Look to your personal development on a continuing basis. This includes your ability to write and speak effectively.**
3. **Keep in mind the "big picture"—see the whole forest, not just your particular tree. Don't fall into the trap of a specialist who "knows more and more about less and less."**
4. **"Accentuate the positive" in your thinking and in your action. Don't be defensive either about your work or about your particular qualifications.**
5. **See that your practice of management is in line with your fundamental belief in good team play and effective group action.**
6. **Get acquainted with yourself. If you would know others, you must first know yourself.**

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generation, leading to decay and death, begins.

Of course, there are many facets of a being in which the apex in this growth curve is reached relatively early, particularly true of the physical side of life. There are some old wives' tales which indicate that this same phenomenon is true regarding the mental-emotional side of life. A you-can't-teach-an-old-dog-new-tricks philosophy has handicapped the personal development of many in business. Not only does it keep some bosses from giving developmental attention to certain of their subordinates, but it keeps many individuals from doing anything for themselves.

This myth should and must be exploded. A person can grow and develop and change, in attitude and in behavior, just about as long as he really wants to do so and in the general direction he basically picks out. In fact, it might be said that a person is going to change and develop for better or for worse anyway, so it behooves him to make this change as positive, as purposeful and as useful as possible.

Self-Analysis for Self-Development: The writer believes that all that is done in appraisal or performance review activities is aimed at helping the individual to see himself and thus to help himself. Thus, part of the process of coaching and counselling which goes on between boss and subordinate involves getting each man to appraise himself. If each person can say, "Yes, I should improve or change that aspect of my performance . . . What can I do about it?", then real development is well on the way.

Six Keys to Personal Development. At this point the reader may well ask: "So what? What do I do next about my personal development?". Here are six keys to follow:

1. Begin now to recognize your chosen profession of management. Such recognition implies a keeping up in your profession. There are evolving philosophies and procedures and techniques with which a bona fide professional manager must be familiar; he gets familiar by participating in management societies and programs and by reading widely, though selectively, in the field of management.

2. Look to your personal development on a continuing basis. This includes your ability to write and speak effectively. There is a growing feeling among many top executives that no one should be permitted to play an important role in management unless he is an effective speaker and writer.

Part of this, naturally, involves how and what you read. It has been well-stated, again and again, that the real leaders in tomorrow's business must be "well-educated men, not trained seals."

If you can't read rapidly enough, expose yourself to some of the techniques in written material and in evening classes on how to speed up your reading and improve your comprehension.

3. Keep in mind the big picture—see the whole forest, not just your particular tree. Don't fall into the trap of a specialist who knows more and more about less and less. Don't lose sight of the over-all objective of your organization. Constantly keep your personal and functional objectives in line with these over-all purposes.

4. Be positive in your thinking and in your actions. Don't be defensive either about your work or about your particular qualifications. Many functional specialists tend to want to defend their particular activity. Remember, "knowledge is power" and if your knowledge is broad enough, your power and recognition also will be broad.

5. See that your practice of management with your subordinates and others in the organization is in line with your fundamental belief in good team play and effective group action. Thus, don't precipitate line-staff conflicts.

If in a staff position, remember that the basic purpose of your function is to facilitate, to improve, to assist, to service, and to advise those individuals who are engaged directly in achieving the basic objectives for which the organization exists. Staff executives with this cooperative point of view do not grasp for line authority or complain that they need more authority to get the job done.

If you are in a line job, recognize that staff people are there to facilitate your activities, in the final analysis, and that your results can be sounder, quicker, easier through the proper use of staff assistance. An effective line executive knows how to use staff organization.

6. Get acquainted with yourself. If you would know others, you must first know yourself. This is not to advocate a morbid introspection; it is to advocate a mature, balanced outlook.

To make a good manager, begin with a good man, and each man must start this management development himself.

As previously emphasized—management development is really self-development. Only through individual self-recognition and development can expect a management leadership be provided in business which is genuinely able to get things done through people.

About the Author

JOSEPH M. TRICKETT has been coordinator of management development for Food Machinery and Chemical Corporation at San Jose, Calif., for the past year. Previously, he was with the American Management Association in New York, where he conducted a nation-wide survey of management-development activities. His other experience includes six years as dean of the School of Management at San Francisco's Golden Gate College; five years as director of organization management with Columbia Steel Company, and similar activities with Standard Oil Company of California. Dr. Trickett is a graduate of Washburn University and holds M.B.A. and Ph.D. degrees from Stanford University.

ACKNOWLEDGMENT

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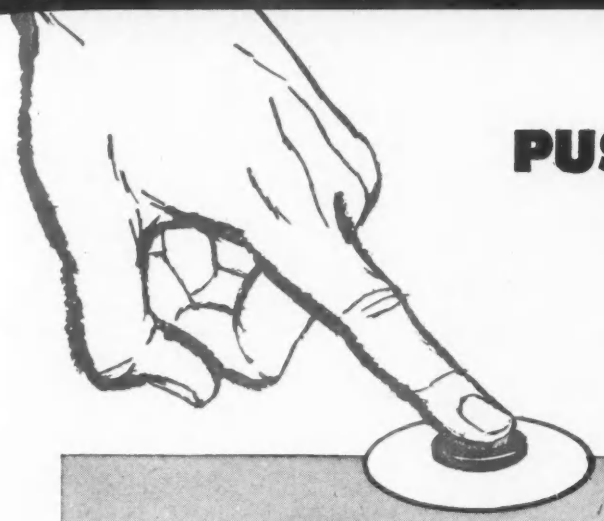

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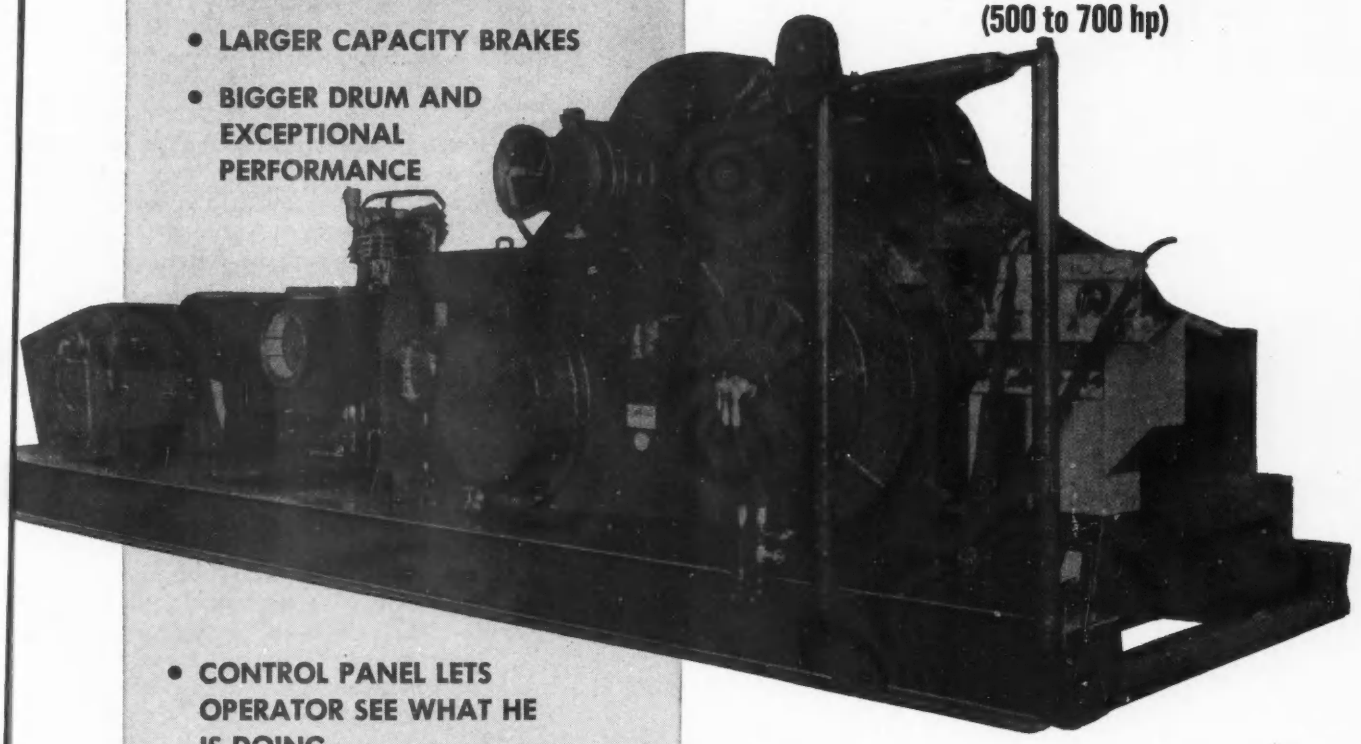

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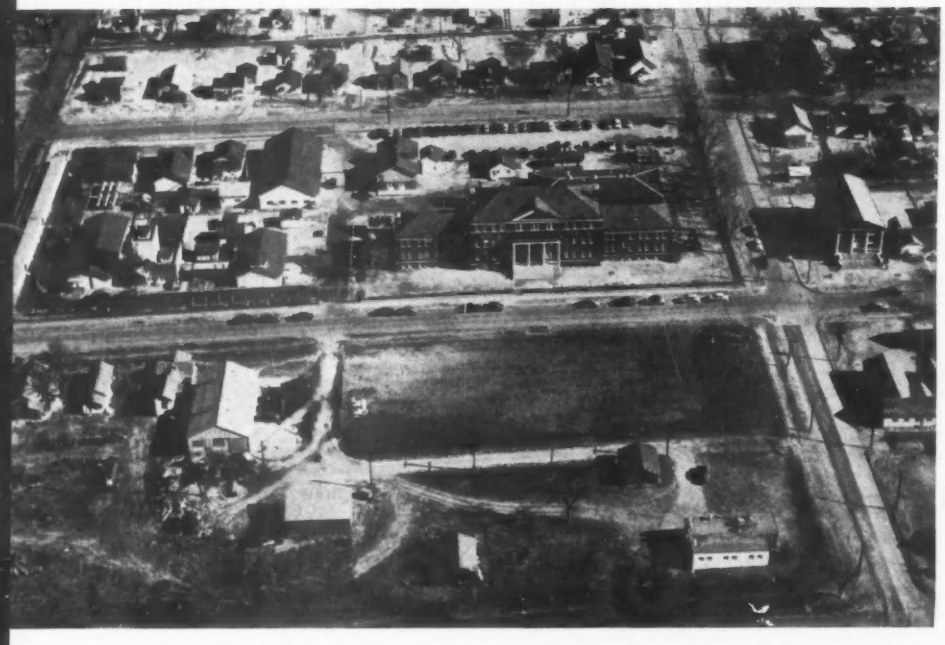


Aerial view from west of Bureau of Mines Petroleum Experiment Station in Bartlesville. Radiochemical building in right foreground. Area between this laboratory and 3-story main administration and chemical-research building (center), bought in 1945 to provide space for physical sciences and engineering building of the future. Such a building would eliminate clutter of small "temporary" buildings on north end of lot. Station grounds with future building area cover 10 acres.

Write Your Congressman!

Bartlesville Bureau of Mines Station Facing Cutback

By ANTHONY GIBBON
World Oil Staff

Unless oil companies and individuals operating in the Mid-Continent area "write their Congressmen" and otherwise let the federal government know how much they benefit from services performed by the Bureau of Mines Petroleum Experiment Station at Bartlesville, Okla., many of these services will be curtailed or discontinued.

The petroleum industry should make its views known NOW to the Department of the Interior and the Bureau of the Budget if important work being done by the Bureau of Mines at Bartlesville is not to fold up for lack of funds.

It is too late now to do anything about the budget for the fiscal year which began July 1st. But the budget for the fiscal year 1958 is being prepared and reports have it that the government plans to use the pruning shears. This would, in the opinion of scores of oil companies and individual operators, be just short of a calamity.

If the over-all petroleum budget is cut, program of the Bartlesville experiment station will suffer. The experiment station receives approximately half of the petroleum division appropriation. A cut any place down the line will bring about an across-the-board work curtailment. Vital projects which are the subject of research to promote more efficient methods for producing oil will have to be suspended.

In urging the Bureau of the Budget at Washington D. C. to provide an adequate budget for the Bureau of Mines Experiment Station at Bartlesville in 1958, the industry should emphasize that:

1. The Bureau of Mines Petroleum Experiment Station does not duplicate industry research. It fills a gap.

2. Thousands of operators not served by big company research and unable to afford research facilities are served constantly by the Bartlesville Station.

3. Work done by the Bartlesville Station is primarily of benefit to the nation and general public.

What the station does and has done. Research objectives of the Petroleum Experiment Station are to improve petroleum-production methods and to promote better utilization of petroleum-industry products, actual and potential, through engineering and chemistry, thus serving the ends of true conservation.

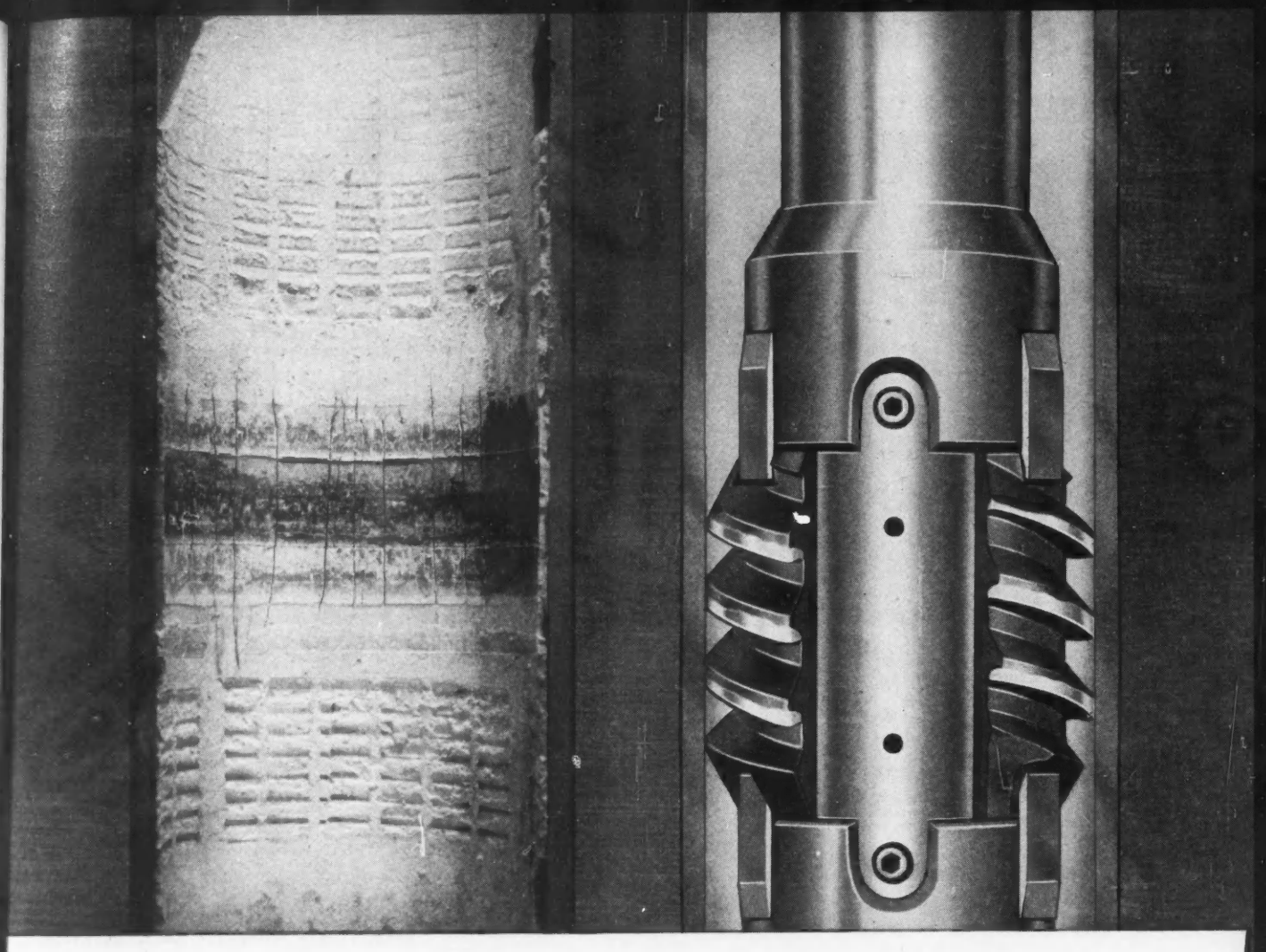
The interrelated technical branches apply experimental and analytical procedures in the following categories:

1. Production of oil: Studies of the behavior of natural reservoir systems and their contained oil, gas, and water in both their primary and secondary stages of development—the latter when energy is restored through methods such as injecting air, gas or water into the underground formations.

2. Chemistry and refining problems: Studies of the characteristics of crude oils and their products, with emphasis on the relationship between properties and composition and on utilization and availability of fuels for all kinds of energy-conversion uses.

3. Thermodynamic properties of pure hydrocarbons and related substances: The acquisition of fundamental data necessary for improvement of refining, utilization, and petrochemical processes.

In addition, transportation of oil



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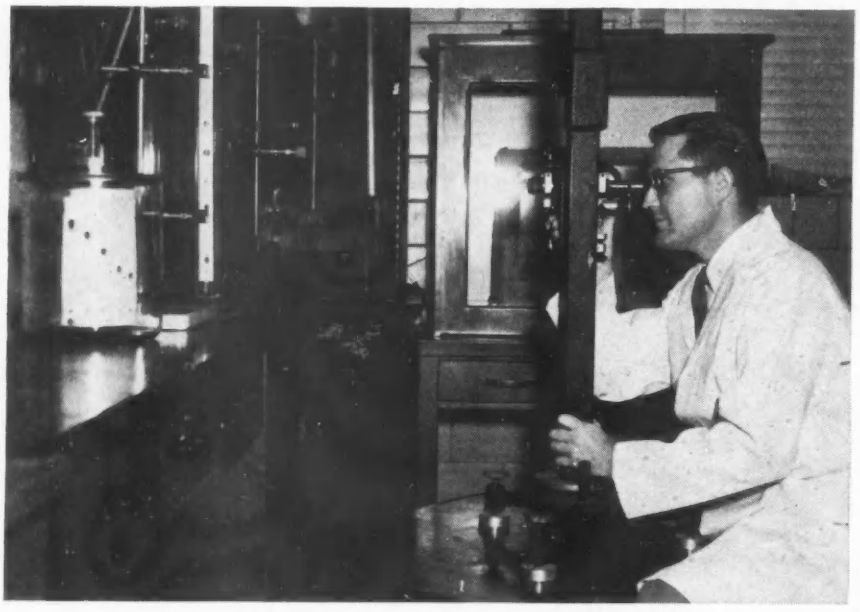
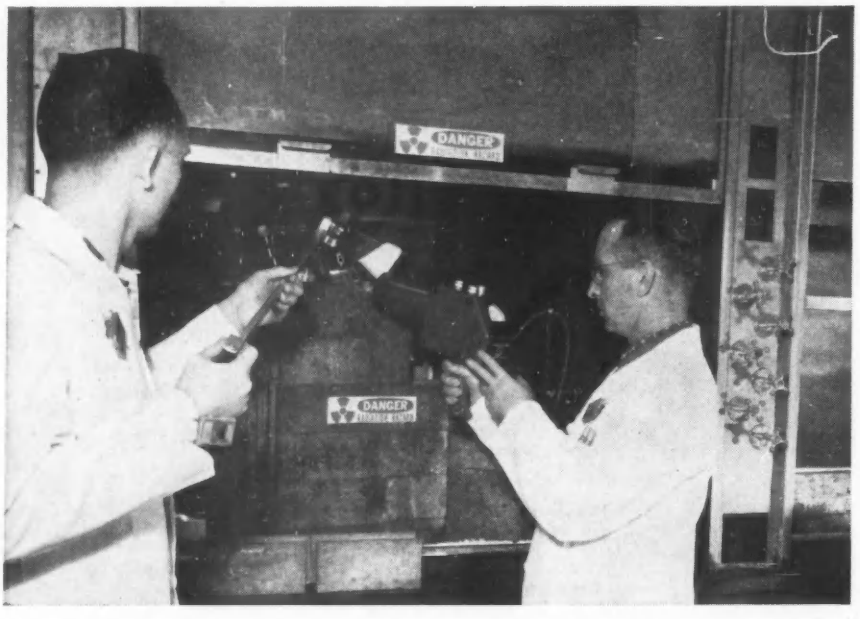


Paper partition chromatography used in Bureau of Mines surface chemistry laboratory. H. N. Dunning, a pioneer in applying this research "tool" to petroleum problems, carefully measures the vertical distance between "spots" on the adsorptive medium with a cathetometer.

and natural gas is another facet of the whole structure of petroleum research in which the station is interested.

The station engages in many functions which are set forth in a pamphlet: "Work of the Petroleum Experiment Station" and which may be obtained by writing the Bureau of Mines, Bartlesville, Okla.

In brief, the ultimate objective is to find ways of producing, refining and transporting more oil and gas economically. It has been especially active in developing water-flood programs and its research into this phase of oil production has played a large part in the development of water-flood projects throughout the Mid-Continent area.



High-level radiation laboratory in Bureau of Mines radiochemical building. Engineers of the Petroleum Experiment Station process radioisotopes in preparation for a field test. The material will be used to trace the flow of water injected into oil-bearing sands to stimulate oil production. Radioactive material is handled behind lead bricks. R. J. Heemstra (left) works behind the shield and sees what he is doing by means of mirrors. J. Wade Watkins observes the radioactivtiy level.

The country faces tremendous problems in its continued efforts to meet the ever-increasing demands for oil and gas. Getting more oil from the ground and improved utilization will solve most of these problems.

Providing increased appropriations for Bureau of Mines Petroleum Research is a key to the problems.

How can this key be used? The Bureau of Mines has a backlog of research that will:

1. Lead to greater initial oil recovery through better use of natural energy.

2. Increase recovery by stimulative methods.

3. Show how to find new fields.

4. Increase petroleum and natural gas reserves.

5. Provide data on petroleum resources and availability for military planning.

6. Furnish basic scientific data for new processes and products.

7. Yield important improved products.

The Bureau is anxious to do more work on:

1. Drilling fluids.

2. Well completion methods, pressure maintenance and gas storage.

3. Treatment, injection and tracing of water in oil field operations.

4. Use of detergents and prevention of corrosion and growth of bacteria.

5. New oil recovery methods, such as underground combustion.

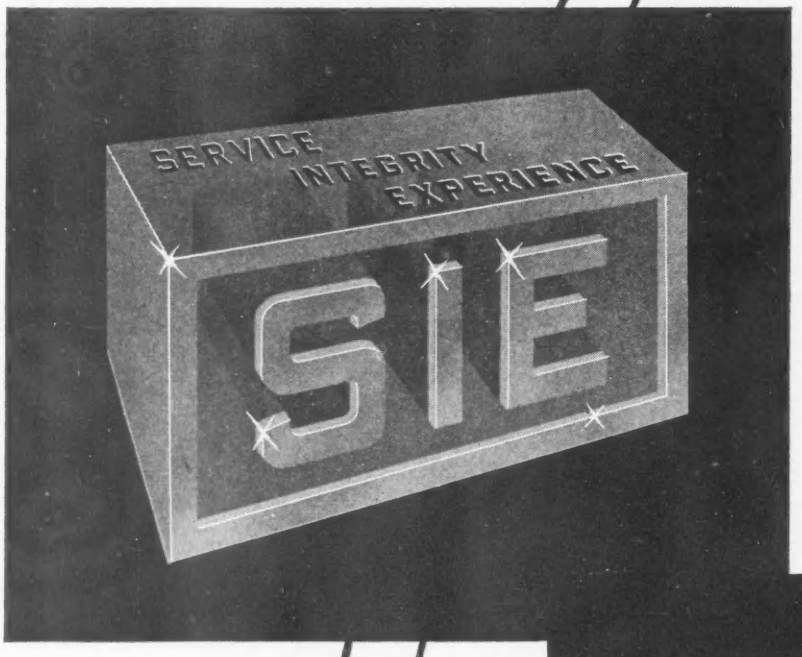
6. Sulfur, nitrogen and trace metals in petroleum.

7. Crude oil composition, and product stability.

8. Heat characteristics of the petroleum products.

These ideas can be put to work for the nation and the industry only if the Bureau of Mines has an adequate research budget for 1958 and the years ahead.

In the last analysis, money, despite its essentiality, does not make a research institution. The vision, forethought and planning of those in charge of and engaged in the work at the Bureau of Mines Petroleum Experiment Station at Bartlesville, have made it an outstanding research institution whose work is recognized throughout the world. **The End**



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By **RAY L. DUDLEY,** Publisher, and **WARREN L. BAKER,** Editor

Higher U. S. Crude Prices Now Unlikely

Prices probably will continue at present levels as high-volume imports and refining offset influence of peak consumption.

HIGHER U. S. CRUDE OIL PRICE prospects have all but disappeared in recent months. Chances are crude prices will remain at present levels. Current conditions do not indicate that a general crude price increase would hold up.

The favorable influence of record consumption has been more than offset by excessive imports and refining operations.

•

PARTICULARLY SIGNIFICANT is the recent trend in gasoline supplies. Despite record consumption, stocks of this product have not been reduced as rapidly as they should for this season of the year. Only 16½ million barrels have been taken from motor fuel stocks this year since beginning of the gasoline consuming season at the end of March. During the same period in 1955, there were 18⅔ million barrels drawn from gasoline storage.

Consequently, inventories of gasoline mid-June were 16⅕ million barrels larger than at the corresponding period of 1955. At the start of the gasoline consuming season, gasoline stocks were but 14 million barrels greater than the year before. Therefore, gasoline inventories remain at an all-time high, totaling 181½ million barrels on June 15.

As a result, local gasoline price wars have occurred in a number of areas and are likely to continue. As long as this condition exists, higher crude oil prices are unlikely.

This situation has been brought about in the face of an all-time record consumption by excessive supplies of gasoline. Refining runs have been increased too much. The first five months of 1955 saw 7.2 percent more crude processed at U. S. refineries than in the same months of 1955.

High crude runs have boosted 1956 gasoline production to 193,000 barrels more per day than during 1955.

•

LARGER CRUDE OIL IMPORTS have further dimmed any chances for higher U. S. crude prices. During the first five months of 1956, U. S. imports of crude oil have averaged 867,000 barrels daily, 133,000 barrels or 18.1 percent more than 1955 rates.

In contrast, U. S. crude production has risen 368,000 barrels, an increase of only 5.4 percent above 1955 volumes.

Imports of refined products have decreased slightly, averaging 504,000 barrels daily in the first five months of this year in contrast with 525,000 barrels last year.

Total imports of crude and products for the January-May period have averaged 111,700 barrels per day more during 1956 than in 1955, an increase of 8.8 percent.

•

ESPECIALLY HARD HIT have been Texas producers. Due to being permitted to produce only 15 to 17 days per month, Texas' production has not increased in proportion to that of some other states. During the first five months of 1956, Texas' production was up 80,000 barrels per day above 1955 rates. However, this was a gain of only 2.7 percent in contrast with the national average of 5.4 percent.

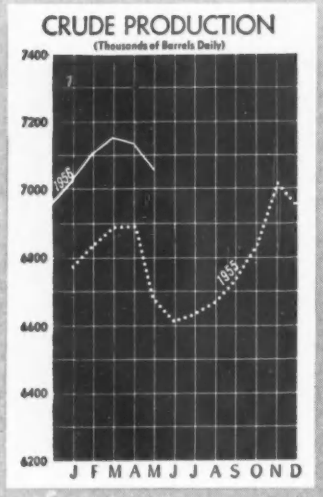
On the other hand, Louisiana produced 88,000 barrels per day more than in 1955, a gain of 12.2 percent. Oklahoma output rose 10.9 percent and that of New Mexico by 10.2 percent.

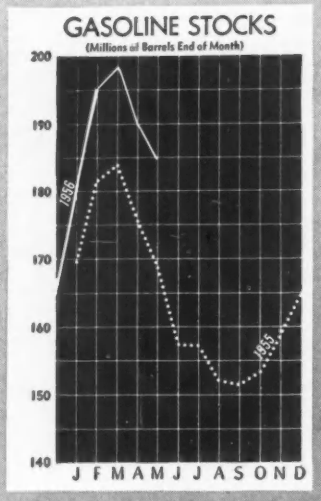
However, Texas producers can look forward to some relief in coming months. Petroleum consumption will increase steadily each month through the remainder of the year. Therefore, national crude output should increase also, and Texas should enjoy a larger share of these future gains than other states.

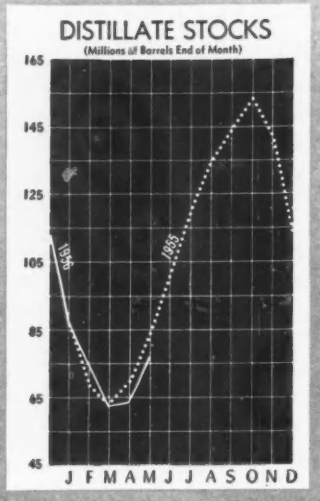
FOR A QUICK PICTURE OF ECONOMIC TRENDS and operating levels of the U. S. petroleum industry turn to the following two pages.

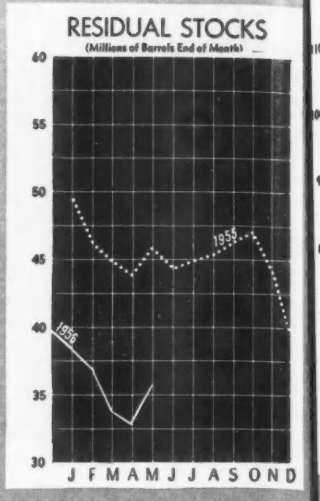
There you will find charts depicting the U. S. trend in all the industry's major operations. Individual charts compare the current year with year ago levels for U. S. crude production, runs to refinery stills, crude oil stocks, gasoline stocks, distillate fuel oil stocks, imports of oil. Then there are charts showing trends in wells completed, footage drilled, active drilling rigs, and active rotary rigs.

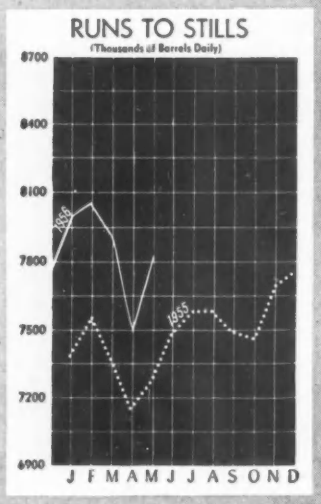
This is a regular monthly feature of WORLD OIL.

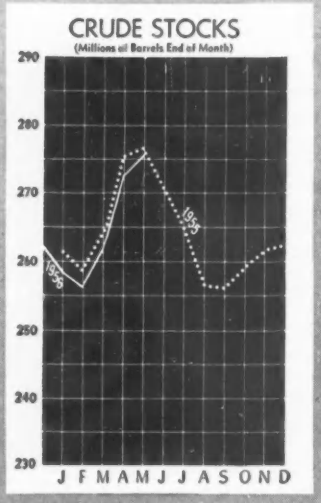












Petroleum Trends In U. S. . . .

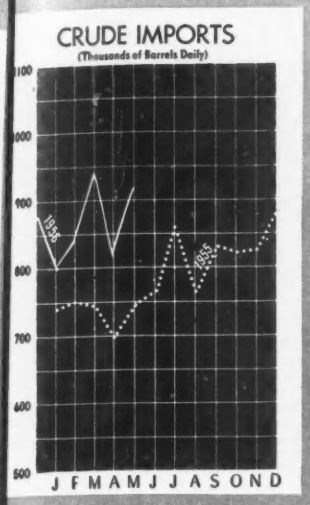
By CECIL W. SMITH, WORLD OIL Staff

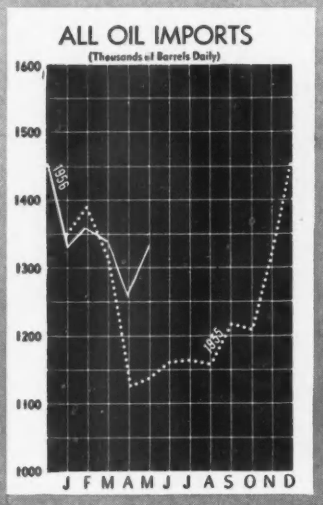
U. S. Crude Production by States

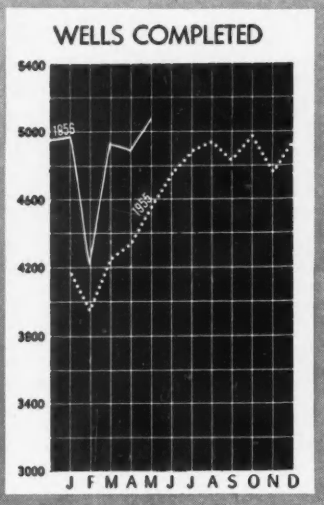
(THOUSANDS OF BARRELS)

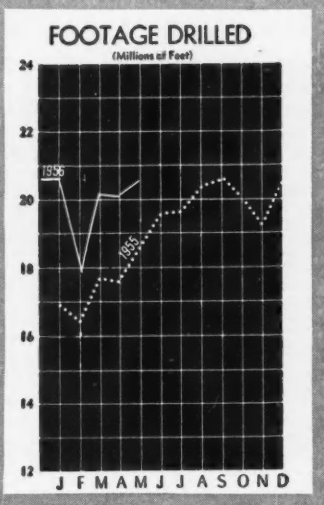
STATE or DISTRICT	DAILY AVERAGE PRODUCTION May, 1956	April, 1956	May, 1955	% Dif. May, '56-'55	TOTAL PRODUCTION First Five Months 1956	1955	% Dif. '56-'55
Alabama	5.0	4.8	3.3	+ 51.5	768	543	+ 41.4
Arkansas	73.3	73.0	80.9	— 9.4	11,447	11,915	— 3.9
California	963.0	964.8	975.2	— 1.3	147,020	146,498	+ 0.4
Colorado	168.2	165.0	141.7	+ 18.7	24,693	19,073	+ 29.5
Florida	1.4	1.4	1.4	.....	209	196	+ 6.6
Illinois	228.4	230.2	223.4	+ 2.2	34,451	32,789	+ 5.1
Indiana	31.4	31.6	30.5	+ 3.0	4,467	4,435	+ 0.7
Kansas	338.2	335.1	310.0	+ 9.1	51,585	50,500	+ 2.1
Kentucky	48.5	47.4	41.4	+ 17.1	7,282	5,984	+ 21.7
Louisiana	797.4	826.0	738.0	+ 8.0	122,933	108,831	+ 13.0
North Louisiana	123.9	120.9	120.2	+ 3.1	19,122	17,871	+ 7.0
South Louisiana	673.5	705.1	617.8	+ 9.0	103,811	90,960	+ 14.1
Michigan	28.9	28.8	30.3	— 5.6	4,595	4,767	— 3.6
Mississippi	111.1	111.8	98.2	+ 13.1	16,981	14,435	+ 17.6
Missouri	0.2	0.2	0.2	.....	27	29	— 6.9
Montana	59.6	53.7	42.2	+ 41.2	8,508	6,607	+ 28.8
Nebraska	38.8	38.5	25.6	+ 51.6	5,992	3,524	+ 70.0
Nevada	0.2	0.3	0.1	+100.0	34	29	+ 17.2
New Mexico	242.8	249.6	220.2	+ 10.3	37,055	33,406	+ 10.9
Southeast New Mexico	241.3	248.1	217.2	+ 11.6	36,684	32,975	+ 11.2
Northwest New Mexico	1.5	1.5	3.0	— 50.0	371	431	— 13.9
New York	10.2	10.1	8.0	+ 27.5	1,309	1,216	+ 7.6
North Dakota	26.0	26.7	19.6	+ 32.7	5,318	4,055	+ 31.1
Ohio	12.8	13.0	11.7	+ 9.4	1,914	1,685	+ 13.6
Oklahoma	585.6	600.9	531.6	+ 10.2	92,330	82,669	+ 11.7
Pennsylvania	19.8	18.9	22.2	— 10.8	3,170	3,384	— 6.3
South Dakota	0.1	0.1	0.1	.....	10	16	— 37.5
Tennessee	0.1	0.1	0.1	.....	6	8	— 25.0
Texas	2,977.2	3,029.7	2,836.8	+ 4.9	464,110	449,015	+ 3.4
Dist. 1: South Central	55.2	55.0	54.1	+ 2.0	8,107	7,742	+ 4.7
Dist. 2: Middle Gulf	158.4	159.7	147.4	+ 7.5	24,285	23,552	+ 3.1
Dist. 3: Upper Gulf	449.9	452.8	449.4	+ 0.1	69,255	70,636	— 2.0
Dist. 4: Lower Gulf-S.W.	240.7	248.6	237.5	+ 1.3	37,713	38,223	— 1.3
Dist. 5: East Central	45.4	45.5	46.0	— 1.3	7,047	7,321	— 3.8
Dist. 6: Northeast	337.7	345.9	335.7	+ 0.6	53,358	54,393	— 1.9
Dist. 7-B: North Central	152.6	160.5	139.2	+ 9.6	23,774	21,270	+ 11.8
Dist. 7-C: West Central	189.2	192.9	189.9	— 0.4	27,983	28,862	— 3.1
Dist. 8: West	1,044.1	1,060.2	914.3	+ 14.2	158,639	144,651	+ 9.7
Dist. 9: North	209.8	213.5	207.6	+ 1.1	31,605	30,030	+ 5.2
Dist. 10: Panhandle	94.2	95.1	87.7	+ 7.4	14,249	13,094	+ 8.8
Utah	5.2	4.9	5.8	— 10.4	812	837	— 3.0
Virginia	0.1	0.1	0.1	.....	5	5	.....
West Virginia	6.0	5.9	6.3	— 4.8	904	978	— 7.6
Wyoming	277.4	271.0	272.1	+ 1.9	42,949	40,600	+ 5.8
Total United States	7,056.9	7,143.6	6,677.0	+ 5.7	1,090,884	1,028,029	+ 6.1

Source: Bureau of Mines and API. Texas districts data from API and do not necessarily agree with State totals.









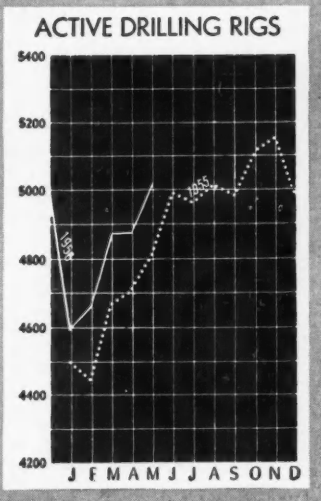
- **Drilling rates at all-time peak**
- **More cuts made in crude output**
- **Oil imports remain at high level**

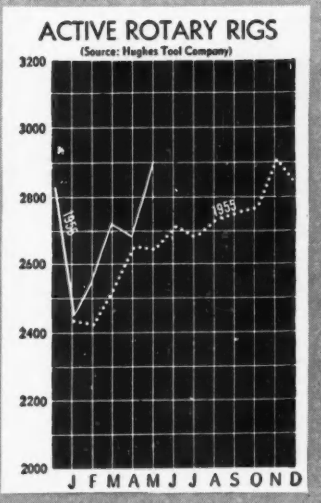
Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1954:											
April	6,615	6,811	280,310	3,404	177,006	1,374	61,721	1,140	44,362	574	950
May	6,471	7,038	282,250	3,482	177,606	1,372	73,581	1,148	47,009	708	1,021
June	6,500	6,947	285,155	3,483	165,404	1,399	86,325	1,123	50,216	624	999
July	6,242	6,916	284,894	3,480	158,010	1,416	101,657	1,089	54,365	724	1,038
August	6,168	6,862	281,043	3,492	153,168	1,453	117,579	1,069	56,322	664	966
September	6,151	6,939	274,608	3,511	150,916	1,514	128,061	1,086	56,702	672	999
October	6,135	6,834	269,442	3,457	149,661	1,545	139,128	1,066	56,541	642	1,065
November	6,346	6,975	264,566	3,530	150,604	1,622	133,886	1,120	54,891	636	1,104
December	6,394	7,238	258,385	3,605	155,400	1,668	108,144	1,187	52,105	729	1,301
1955:											
January	6,761	7,379	260,156	3,639	169,562	1,740	86,692	1,235	49,457	739	1,348
February	6,835	7,549	258,630	3,655	181,643	1,847	68,513	1,239	46,042	751	1,379
March	6,886	7,374	264,430	3,543	183,972	1,703	62,457	1,185	44,970	742	1,319
April	6,887	7,136	275,232	3,502	175,601	1,534	70,139	1,110	43,838	697	1,123
May	6,677	7,281	276,948	3,605	168,751	1,519	83,559	1,111	45,083	742	1,137
June	6,613	7,484	270,850	3,725	157,439	1,628	100,652	1,080	44,398	764	1,159
July	6,632	7,580	264,601	3,824	157,079	1,575	119,169	1,091	44,894	860	1,161
August	6,665	7,580	256,427	3,858	151,912	1,621	133,675	1,090	45,480	756	1,155
September	6,731	7,483	256,269	3,784	150,194	1,621	143,248	1,061	46,267	829	1,218
October	6,831	7,465	267,346	3,827	153,103	1,612	152,288	1,123	47,040	821	1,206
November	7,014	7,692	260,707	3,867	157,871	1,680	141,808	1,214	44,071	823	1,322
December	7,155	7,762	265,610	3,916	165,433	1,765	111,333	1,286	39,174	884	1,502
1956:											
January	7,199	8,023	261,592	3,927	183,905	1,923	86,141	1,344	38,247	805	1,422
February	7,208	8,047	259,504	3,854	196,092	1,918	71,335	1,286	35,673	878	1,472
March	7,278	7,914	265,683	3,829	199,698	1,808	60,846	1,213	32,984	934	1,425
April	7,144	7,501	274,030	3,581	189,770	1,720	62,810	1,139	32,790	829	1,252
May	7,057	7,865	276,390	3,715	184,676	1,705	76,632	1,174	35,686	919	1,337
May, 1956 Change:											
In Month	−87	+364	+2,360	+134	−5,094	−15	+13,822	+35	+2,896	+90	+85
In Year	+380	+584	−558	+110	+15,925	+186	−6,927	+63	−9,397	+177	+200
Week Ended:											
6-15-56	7,066	7,953	274,075	3,909	181,487	1,721	84,996	1,080	37,319	786	1,198
6-17-55	6,626	7,520	275,768	3,648	165,285	1,601	91,269	1,158	45,684	817	1,196

Source: Data for last two months from API; prior monthly data from Bureau of Mines.





U. S. Wells Completed in May and First Five Months, 1956-1955

STATE or DISTRICT	NEW WELLS COMPLETED AND FOOTAGE DRILLED — DETAILS FOR MAY: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Salt Water Disp.	TOTAL NEW WELLS: May 1956	April 1956	May 1955	Total Footage May, 1956	DETAILS FOR JANUARY–MAY — NEW WELLS: 1956	1955	Percent Diff.	FOOTAGE: 1956	1955	Rigs in Operation: May 31, 1956	April 30, 1956	May 31, 1955
Alabama	6			6				12	7		68,955	36	27	+ 33.3	275,657	115,776	17	14	4
Arizona													4	—100.0		16,136	1		
Arkansas	37		2	23				62	76	80	186,747	333	282	+ 18.1	1,071,382	921,204	60	48	39
California	142		6	32				180	177	220	834,382	906	1,008	— 10.1	4,243,092	4,878,065	216	223	245
Colorado	37	1	10	73				121	93	129	609,658	554	581	— 4.7	2,936,763	3,138,318	60	59	89
Florida										2		6	14	— 57.2	35,002	83,221			
Georgia				2				2	1		9,269	3			12,819		1	2	
Idaho												1	2	— 50.0	4,528	7,305	1		
Illinois	139		2	178				319	318	256	751,529	1,382	1,339	+ 3.2	3,261,575	3,233,866	300	265	303
Indiana	13			31	1			45	42	51	83,152	225	219	+ 2.7	394,590	341,263	90	84	100
Kansas	197		28	190			9	424	392	409	1,536,327	1,906	1,874	+ 1.7	6,942,174	6,865,020	430	455	498
Kentucky	55		19	62	1	1		138	150	119	200,049	706	570	+ 23.9	1,000,211	953,149	116	121	117
Louisiana	190	11	25	117			1	344	304	369	2,436,286	1,486	1,663	— 10.7	11,197,002	10,251,750	435	437	390
North Louisiana	102		7	55				164	135	209	512,408	577	876	— 34.1	2,056,879	2,471,458	93	77	76
South Louisiana	88	11	18	62			1	180	169	160	1,923,878	909	787	+ 15.5	9,140,123	7,780,292	342	360	314
*Gulf of Mexico	20		7	10				37	36	28	346,148	186	123	+ 51.2	1,699,654	1,138,951	79	68	52
Maryland																	3	3	5
Michigan	16			16				32	24	41	93,993	188	203	— 7.4	527,865	590,087	78	58	85
Mississippi	9	1	3	15				28	40	38	188,920	173	200	— 13.5	1,263,078	1,506,012	26	29	42
Missouri									1	3		15	20	— 25.0	13,595	11,063			4
Montana	13			15				28	24	28	137,579	157	115	+ 36.5	835,603	596,974	60	47	37
Nebraska	24			62				86	87	84	489,219	414	283	+ 46.3	2,355,781	1,634,203	40	45	49
Nevada				1				1	1	1	7,349	3	5	— 40.0	24,752	36,528	3	4	1
New Mexico	76		61	28				165	166	173	702,230	770	646	+ 19.2	3,487,773	2,743,584	232	203	165
New York	22				15			37	33	28	51,200	151	135	+ 11.9	213,600	186,593	57	52	49
North Dakota	17			8				25	25	24	188,940	119	96	+ 24.0	906,067	702,322	22	20	19
Ohio	52		7	24				83	94	101	237,926	429	437	— 1.8	1,102,016	929,279	212	218	206
Oklahoma	447	3	38	226	3		9	726	690	677	2,609,225	3,516	2,949	+ 19.2	12,713,388	9,960,815	644	644	644
Oregon												1			12,880				1
Pennsylvania	22		41	16	20	1		100	92	55	262,341	486	293	+ 65.9	1,257,540	550,694	140	142	110
South Dakota									2			3	4	— 25.0	19,542	24,038	5	4	2
Texas	1,138	27	60	732	37			1,994	1,939	1,564	8,264,407	9,544	7,750	+ 23.1	40,192,375	34,082,206	1,465	1,439	1,326
Dist. 1: South Central	144		2	57				203	173	155	560,658	881	724	+ 21.7	2,427,218	1,955,308	66	71	52
Dist. 2: Middle Gulf	21	6	6	28				61	81	72	394,607	363	332	+ 9.3	2,250,632	2,003,371	52	57	38
Dist. 3: Upper Gulf	82	4	3	55				144	172	146	994,689	761	719	+ 5.8	5,046,881	4,667,369	147	157	127
*Gulf of Mexico										1		4	7	— 42.9	40,088	70,548	1	1	3
Dist. 4: Lower Gulf-S.W.	48	15	7	59				129	118	105	692,593	588	557	+ 5.6	3,063,769	2,906,836	96	77	68
*Gulf of Mexico	1			1				2	1	1	20,497	6	7	— 14.3	60,723	63,743	3	3	2
Dist. 5: East Central			2	17				19	23	22	79,623	109	120	— 9.2	372,119	496,189	7	8	13
Dist. 6: Northeast	40	1	6	36				83	85	59	456,202	378	255	+ 48.2	1,982,958	1,416,425	81	73	66
Dist. 7-B: North Central	114		4	130				248	278	197	878,766	1,366	1,240	+ 10.2	4,717,034	3,723,818	150	156	157
Dist. 7-C: West Central	74			42				116	111	107	573,036	550	521	+ 5.6	2,583,675	2,832,497	136	120	134
Dist. 8: West	256	1	1	93				351	352	297	1,695,253	1,706	1,470	+ 16.1	8,734,372	7,979,735	375	338	380
Dist. 9: North	257		2	201	37			497	450	312	1,424,394	2,292	1,384	+ 65.6	6,957,156	4,629,684	245	270	220
Dist. 10: Panhandle	102		27	14				143	96	92	514,586	550	428	+ 28.5	2,057,161	1,470,974	116	111	71
Utah	3		4	14				21	6	3	99,488	64	38	+ 68.4	299,427	186,416	23	16	17
Washington												1			7,493				
West Virginia	5		48	7				60	38	42	158,609	292	236	+ 23.7	778,974	637,329	186	170	184
Wyoming	36		3	31				70	68	66	304,089	379	292	+ 29.8	1,794,272	1,453,700	96	84	82
Total United States	2,696	43	357	1,909	77	2	19	5,103	4,890	4,563	20,511,869	24,249	21,285	+ 13.9	99,180,816	86,636,916	5,019	4,886	4,816
Total Western Canada	121		5	30			1	157	171	113	758,223	968	887	+ 9.1	4,678,524	3,884,129	207	159	144

*Gulf of Mexico wells are included in their respective District totals.

Drilling Peak Reached in May

Near-record number of drilling rigs are holding operations 14 percent over 1955 level.

THE NATION'S DRILLERS completed 5103 new wells during May to set a new monthly drilling record. It was the first time in history that the 5000-new well mark had been reached in a single month.

May's record-breaking operations boosted the year's wells to a lead of almost 14 percent over the previous peak drilled in 1955. Indicating a continuance of high-level activity was the near-record number of drilling rigs in the field at the close of the month.

The 5103 new wells recorded in May ran the year's five-month total to 24,249 new wells, which was 13.9 percent more than the 21,285 completed in the same period of 1955, which became the greatest drilling year in the U. S. industry's history. There would have to be some very drastic set-backs in this year's drilling campaign to prevent a new record from being reached, and it would appear at this point that about the only question is how much will the final total exceed 60,000 wells. Only a few years ago the charmed circle was 50,000 new wells in a single year, now that barrier has been broken a couple of times, and the next goal appears to be not so far away.

At the end of May, a total of 5019 drilling rigs were working. That was a new high for the year, and it was also a concentration of drilling units that was not amassed until the end of August last year, or three months later.

Actually, drilling efforts have been somewhat more rigorous than the number of wells indicate. So far this year, footage drilled has totaled 99,-180,816 feet, which amounted to 14.5 percent more than the 86,636,916 feet recorded a year earlier. On the average, this year's wells have been drilled to a depth of 4090 feet, while last year's tests averaged 4070 feet each.

The 99 million feet already drilled this year was almost equal to the total recorded in the whole of 1946, and was considerably more than annual footage in most pre-war years.

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4. Sizes 3½ in. OD and 4½ in. OD come in weights lighter than standard.
5. Beth-Co-Weld comes in single mill lengths; also in double mill lengths up to 50 ft for sizes 1½ in. through 4½ in. OD.
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Wildcat Drilling—In May and First Five Months, 1956-1955

STATE or DISTRICT	MONTH OF MAY, 1956						FIRST FIVE MONTHS, 1956-1955								
	New Fields			Total Discoveries	Dry Wildcats	Total Wildcat Tests	New Fields			Total Discoveries		Dry Wildcats		Total Wildcat Tests	
	Oil	Dist.	Gas				Oil	Dist.	Gas	5 Mo. 1956	5 Mo. 1955	5 Mo. 1956	5 Mo. 1955	5 Mo. 1956	5 Mo. 1955
Alabama	..	..	..	..	5	5	...	..	1	1	...	11	27	12	27
Arizona	..	..	..	..	..	..	...	..	..	...	...	....	4	....	4
Arkansas	1	..	1	2	10	12	3	..	3	6	6	50	54	56	60
California	..	..	2	2	18	20	1	..	3	4	9	106	128	110	137
Colorado	4	1	..	5	57	62	13	1	3	17	32	244	292	261	324
Florida	..	..	..	..	..	..	...	..	..	...	...	6	13	6	13
Georgia	..	..	..	..	2	2	...	..	..	...	...	3	....	3	....
Idaho	..	..	..	..	..	..	...	..	..	...	...	1	2	1	2
Illinois	2	..	..	2	73	75	9	..	..	9	4	335	237	344	241
Indiana	..	..	..	..	9	9	1	..	..	1	7	55	54	56	61
Kansas	21	..	3	24	105	129	82	..	12	94	75	422	359	516	434
Kentucky	1	..	..	1	12	13	2	..	..	2	8	57	35	59	43
Louisiana	5	1	4	10	45	55	12	11	9	32	22	205	174	237	196
North Louisiana	..	..	..	..	18	18	...	..	..	...	1	70	63	70	64
South Louisiana	5	1	4	10	27	37	12	11	9	32	21	134	111	167	132
Michigan	1	..	..	1	12	13	3	..	..	3	2	60	79	63	81
Mississippi	1	1	..	2	7	9	1	2	..	3	2	62	74	65	76
Missouri	..	..	..	..	..	..	...	..	..	...	...	9	13	9	13
Montana	..	..	..	..	9	9	4	..	1	5	1	45	33	50	34
Nebraska	7	..	..	7	43	50	20	..	..	20	15	194	105	214	120
Nevada	..	..	..	..	1	1	...	..	..	...	...	1	4	1	4
New Mexico	6	..	..	6	15	21	18	..	1	19	16	75	58	94	74
North Carolina	..	..	..	..	..	..	...	..	..	...	...	....	....	....	....
North Dakota	3	..	..	3	7	10	8	..	..	8	...	28	16	36	16
Ohio	..	..	..	..	..	..	...	..	..	...	1	2	12	2	13
Oklahoma	9	2	3	14	70	84	45	10	13	68	45	308	234	376	279
Oregon	..	..	..	..	..	..	...	..	..	...	...	1	....	1	....
Pennsylvania	..	..	..	..	..	..	...	..	..	...	...	....	....	....	....
South Dakota	..	..	..	..	..	..	...	..	..	...	...	3	4	3	4
Tennessee	..	..	..	..	..	..	...	..	..	...	...	....	....	....	....
Texas	43	3	9	55	445	500	215	20	41	276	270	2,013	1,646	2,289	1,916
Dist. 1: South Central	2	..	..	2	34	36	13	..	4	17	3	214	33	231	36
Dist. 2: Middle Gulf	1	1	2	4	20	24	5	4	3	12	15	98	95	110	110
Dist. 3: Upper Gulf	2	..	..	2	31	33	9	7	4	20	20	180	165	200	185
Dist. 4: Lower Gulf-S.W.	2	1	2	5	40	45	6	5	8	19	21	163	170	182	191
Dist. 5: East Central	..	..	..	..	11	11	...	..	..	...	5	55	57	55	62
Dist. 6: Northeast	..	..	..	..	22	22	6	1	2	9	4	101	67	110	71
Dist. 7-B: North Central	15	..	2	17	92	109	73	..	5	78	86	439	412	517	498
Dist. 7-C: West Central	4	..	..	4	34	38	20	..	2	22	17	114	110	136	127
Dist. 8: West	6	1	1	8	56	64	36	1	2	39	39	199	196	238	235
Dist. 9: North	9	..	..	9	100	109	40	..	5	45	64	419	258	464	322
Dist. 10: Panhandle	2	..	2	4	5	9	7	2	6	15	6	31	20	46	26
Utah	..	..	..	..	13	13	1	..	2	3	3	44	25	47	28
Washington	..	..	..	..	..	..	...	..	..	...	...	1	....	1	....
West Virginia	..	..	..	..	..	..	...	..	..	...	6	....	10	....	16
Wyoming	2	..	1	3	19	22	5	1	2	8	11	94	66	102	77
Total United States	106	8	23	137	977	1,114	443	45	91	579	535	4,435	3,758	5,014	4,293

Wildcatters Set New Record

1114 tests completed in May made it most active month, and upped year's lead to 16.8%.

MAY WAS THE busiest wildcatting month in history as a total of 1114 tests were completed. This new monthly peak boosted the year's wildcat wells into a 16.8 percent lead over the 1955 record.

The month's activity resulted in not only a great number of completed tests, but the successful results were a little better than average. The 137 new oil, distillate, and gas field openers completed during May amounted to 12.3 percent of the total wells drilled, while the average, so far this year, has amounted to only 11.5 percent.

In five months, the nation's wildcatters completed 5014 tests—579 of which proved commercially productive—to top the 4293 drilled in the same period of last year by 16.8 percent. This lead was extended during the month from the 15.6 percent margin held at the end of April.

All types of drilling—wildcat and development—have been carried on at record rates so far this year, with slightly greater emphasis on exploration. Compared with 1955, which was the most active drilling year, total drilling activity in 1956 has been 13.9 percent higher, while wildcatting has enjoyed a 16.8 percent edge. Of all wells drilled in the first five months of this year, 20.7 percent were classed as wildcats, and a year earlier 20.2 percent had been exploratory tests.

Through May, 443 new oil fields had been opened, and these numbered 8.8 percent more than the 407 discovered in the comparable period of last year. However, instead of an 8.8 percent increase new oil discoveries should have been 16.8 percent higher than last year to maintain an even pace with the 1955 score. In other words, 475 new oil fields should have been opened instead of the 443, if the 1955 par had been matched.

This year's gas and gas-distillate discoveries, numbering 136 to last year's 128, also failed to match up with the increase in activity. These finds amounted to only 6.3 percent more than the earlier year's.

Summary of Results of Wildcat Drilling

ITEM	May, 1956	April, 1956	FIVE MONTHS January- May 1956	FIVE MONTHS January- May 1955	Percent Diff.
New Field Discoveries:					
Oil	106	86	443	407	+ 8.8
Distillate	8	8	45	46	— 2.2
Gas	23	21	91	82	+ 11.0
Total Discoveries	137	115	579	535	+ 8.2
Dry Wildcats	977	893	4,435	3,758	+ 18.0
Total Wildcats	1,114	1,008	5,014	4,293	+ 16.8
Percent Productive	12.3	11.4	11.5	12.5	.....
Percent Dry	87.7	88.6	88.5	87.5	.....

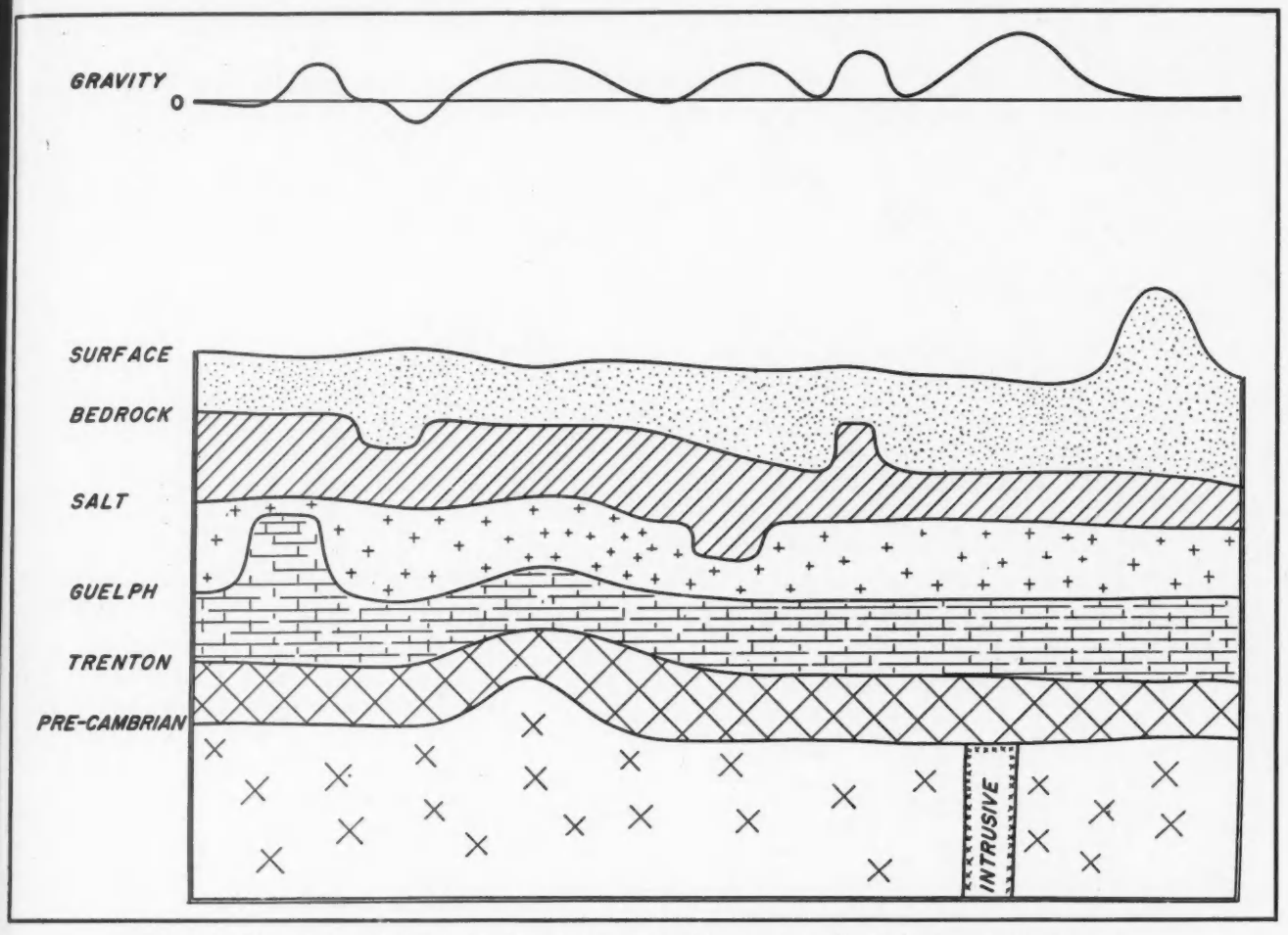

FIGURE 1—Diagrammatic sketch of subsurface structures with related gravity profile. Profile is compressed laterally.

Reefs Are Hard to Find

The gravity meter is finding widespread importance in the definition of structures often overlooked by other geophysical methods. This is particularly true in locating hard-to-find reef type structures.

By RICHARD A. POHLY
Pohly Exploration Company, Tulsa

EASILY-FOUND OIL structures have been very nearly exhausted and the industry must rely more and more on the geophysicist to map structures which have no surface expression. The seismograph has long been recognized as a useful tool for detailing subsurface structure, but many areas because of glacial drift, erratic velocities or extremely difficult terrain, make use of the seismograph difficult. In planning an exploration program for such areas, the producer should consider the gravity method.

The gravity meter, as a geophysical tool for locating oil and gas traps, has been used less in the northeastern U. S. than it has in any other similar oil producing area. It is probable that this lack of utilization has been the result of two distinct attitudes on the part of the producer. In the first place, the Appalachian geosyncline is considered to be the birthplace of the anticlinal theory of oil and gas accumulation and it is true that most structures in that area are associated with mapable surface features. For this reason surface mapping by the geologist has been an adequate tool

FIGURE 2—Map of Ohio showing Newburg production and zone most favorabe for Niagaran reefs. (After Flato, 1955)

for locating traps. In the second place, the gravity meter has too frequently been considered only a reconnaissance tool useful in mapping large areas in basins where subsurface information is limited.

Although the gravity meter has been in use as an exploration tool for more than 20 years, a great many people in the petroleum industry know little about either the instrument or its use, so a brief description of the instrument and its application may help some of the readers to better understand the suggestions which are made later.

The gravity meter itself is nothing more than an extremely sensitive spring balance with which even very slight changes in the force of gravity are measured. These changes in the force of gravity result from changing densities in the subsurface rocks. Figure 1 is a diagrammatic sketch of a number of features which are commonly found in the subsurface rocks of the area under discussion, along with a profile of the approximate gravity anomalies which would accompany these features. At the right hand edge of this diagram is shown a sharp change in the surface elevation. It will be noted that this does not produce any effect on the gravity profile because it is possible to measure the change in elevation and make proper corrections to remove the gravity effects.

The bedrock surface in most areas has been affected by erosion and glacial action. This effect is represented by a small "high" extending well above the average bedrock elevation and, near the left hand side of the figure, a channel in the bedrock surface. These features cause a gravity maximum and a gravity minimum which are caused by the change in density between the unconsolidated surface material and the more dense bedrock. A similar condition occurs at the interface between the salt and the overlying rocks, where these rocks have a density higher than salt.

On the extreme left hand side of the illustration, is shown a Niagaran reef which causes a sharp increase in the elevation of the Guelph surface. Since such a reef causes the limestone or dolomite to occupy the horizon normally occupied by the salt, a gravity maximum is produced on the gravity profile. Similarly a ridge in the Pre-Cambrian surface causes dense rocks to be folded up into the same horizontal plane with rocks of lower density and, therefore, causes a gravity maximum.

Another feature in the subsurface which causes sharp anomalies in the gravity map is that of a very dense intrusive within the Pre-Cambrian, a condition also represented in Figure 1. It should be pointed out that the gravity profile is considerably compressed in the illustration to allow all of the features to show. Actually the width of any gravity anomaly is nearly four times as great as the depth to the mass causing the anomaly. This relation of width to depth permits the gravity interpreter to make rough depth approximations in any given area. Of all the effects shown on this diagram, the only two which would have any relation to oil or gas accumulation would be the Guelph reef and the anticline associated with the Pre-Cambrian ridge. The interpreter would attempt to remove the effects of the other features to better define these structures.

Reefs. In recent years the discovery of oil and gas in the Guelph-Lockport reefs has attracted considerable attention. These reefs have been found to be prolific producers in Illinois, Indiana, Michigan and Ontario. In 1955 the Ohio Geological Survey, in its publication "Oil and Gas In Ohio," 1954, included an excellent paper by Bernard A. Floto entitled "The Possible Presence of Buried Niagaran Reefs in Ohio and Their Relationship To the Newburg Oil and Gas Zone."[1] Figure 2 is a copy of Floto's map from that paper showing the location of Newburg oil and gas pools and areas favorable for Newburg production. A majority of these known reefs were discovered by random drilling and, as would be expected, are situated along the trends where drilling has been most intensive. Floto (1955 p. 41-52) suggests that zones A and B provided the best areas for future exploration. This same thinking could be extended to include the northwestern portion of Pennsylvania and western New York. Ver Wiebe (1952 p. 13) notes that a similar reef has been found near Geneva in Ontario County, New York.[2]

These reefs are pinnacle type bioherms and usually occur as circular bodies having a diameter which varies from a few hundred feet to two or three miles, and a vertical dimension ranging from a few feet to several hundred. Figure 3 is a diagram of a typical Niagaran reef. The reef core is an undifferentiated mass of highly porous limestone or dolomite made up largely of fossil remains. The very high porosities in the upper part of the reef cause the limestone or dolomite to be of low density; however, in most cases it has been found that the lower part of the reef is extremely dense through secondary filling of the pores. The reef flank consists of steeply dipping beds made up largely of reef detritus. These beds interfinger with the normal inter-reef facies. The reef exerts considerable influence on the beds directly above it, causing marked thinning in salt or shale, and well-defined structure in limestones. The effect which these various deformations have on the gravity has been described in several publications (Pohly, 1953, Pohly, 1954).[3] For the purpose of this paper we will only mention that the net effect is a gravity maximum resulting from the extra densities in the lower part of the reef, and the extra compaction in the beds above and below the reef. The effect which a reef produces on the gravity contours is shown in Figure 4. This illustration is the Bouguer map of an area surrounding the Dawn No. 156 pool in southwestern Ontario. On this map all of the effects of changing densities in the subsurface tend to influence the gravity, and only a person with considerable experience in gravity interpretation can detect the anomaly associated with the reef itself. Many devices have been employed by the geophysicist to separate the important anomalies from the many unimportant gravity effects in such an area. These are well described by Nettleton (1954).[4]

Figure 5 shows a residual gravity map of the same area. This map indicates only the anomaly which is believed to be associated with the reef. To produce this map the interpreter makes an intermediate map on which the contours represent the average gradient in the area, and do not contain the small distortions found on the Bouguer map. The values along these smooth contours are then subtracted from the Bouguer contours. An additional subtraction is made wherever anomalies appear to be too small or too erratic to be of importance. The final result is then the residual map which, quite reliably, indicates only the anomalies which, by size and intensity, could be produced by Niagaran reefs.

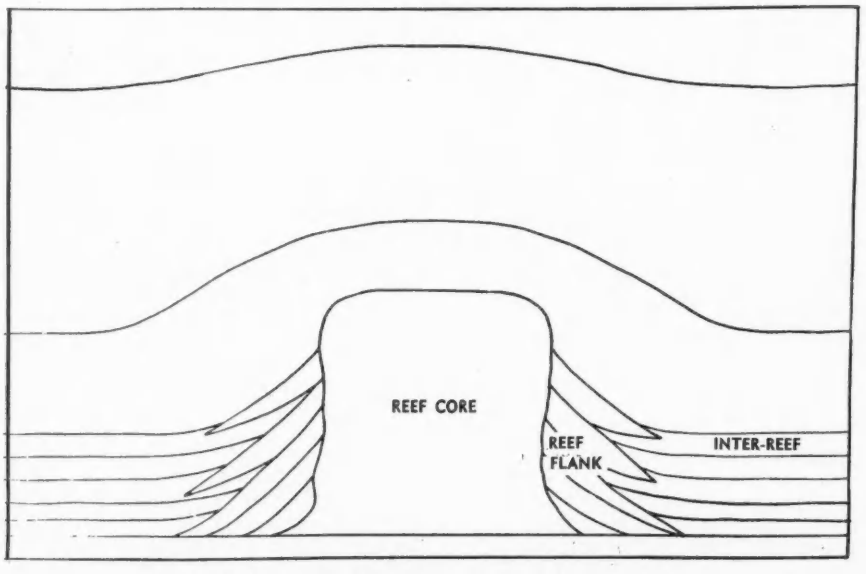

FIGURE 3—Schematic diagram of typical Niagaran reef.

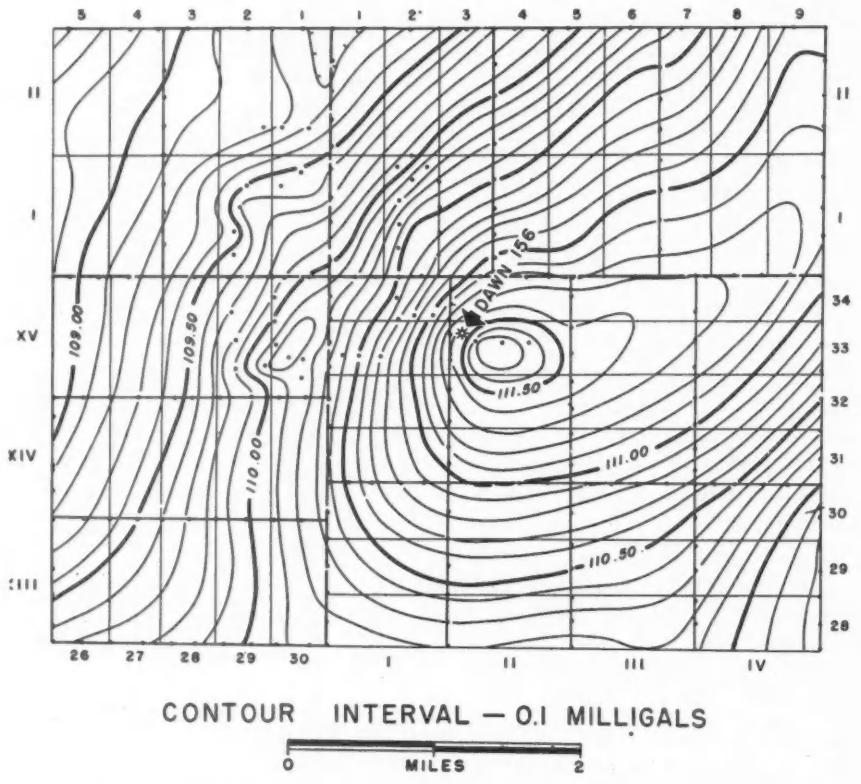

FIGURE 4—Bouguer gravity map of Dawn No. 156 pool, Ontario, Canada.

The gravity method has been extensively used on reef problems in Indiana, Illinois, Michigan and Ontario. In those areas, over the last several years, approximately forty reefs have been found by drilling on gravity anomalies. The writer has had an opportunity to observe the anomalies associated with three of the Newburg reefs described in Floto's paper, and it has been found that the anomalies associated with these reefs are very similar to those found in the above mentioned areas. It would, therefore, appear that the gravity method should provide an excellent tool for locating Niagaran reefs wherever they may occur in the Appalachian geosyncline.

General Problems. The gravity method has also been successful in other areas in mapping faults and anticlines wherever density contrasts between adjacent beds are sufficient to produce interpretable anomalies. Such a condition is known to exist in the Appalachian area and the gravity meter should be considered as a good potential tool for mapping such structures wherever they cannot be adequately mapped by surface methods. It should be noted however, that the rough terrain and sharp changes in surface densities so common in much of the Appalachian area would require very accurate surveys and adequate corrections for these surface conditions.

To be effective, a gravity survey must cover enough area to provide accurate information regarding the regional gravity effects. To meet this requirement, a township should be considered the absolute minimum of coverage for any problem, however, the gravity stations are generally placed along roads and such coverage is very rapid. In most areas a gravity crew can secure adequate control at a rate of approximately one township per week.

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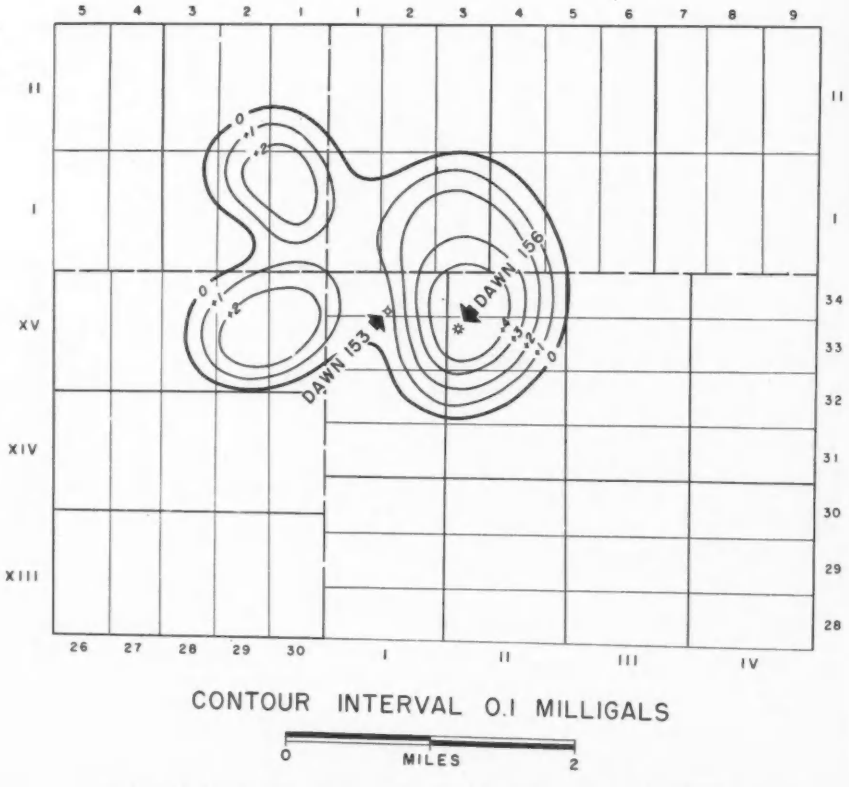
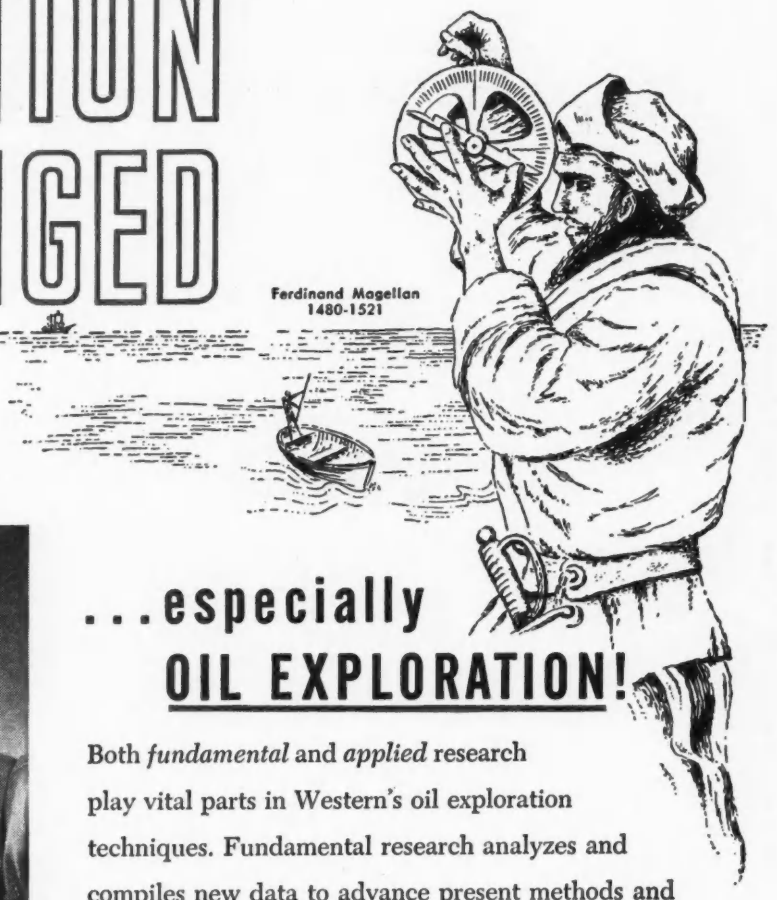


FIGURE 5—Residual gravity map of Dawn No. 156 pool, Ontario, Canada.

EXPLORATION HAS CHANGED



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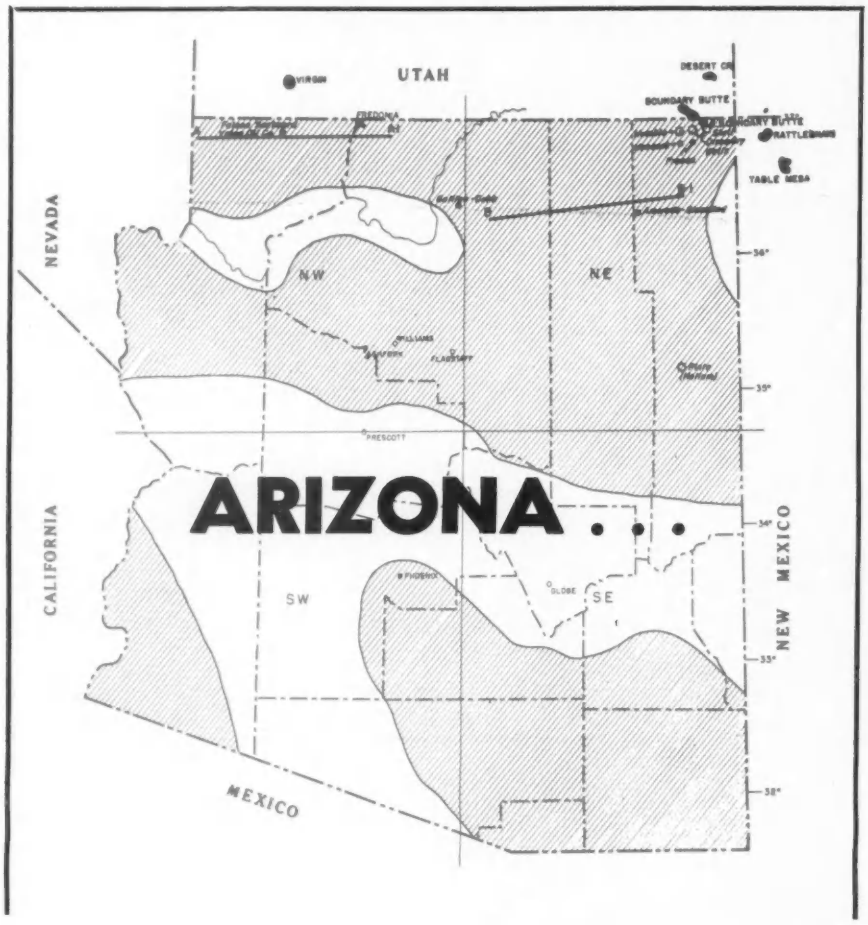


FIGURE 1—Potential oil and gas stratigraphic areas of Arizona.

BOOM OR BUST?

Four-fifths of the state has good possibilities for developing commercial oil and gas production. Here's one geologist's evaluation.

By CLOYD W. SWAPP
Valen Oil and Minerals Corporation
Phoenix, Ariz.

FOUR-FIFTHS of the state of Arizona may cover a vast oil and gas reserve! Basic geologic requirements conducive to productive horizons are evident.

The rate at which Arizona may become a major producing state will depend upon members of the oil and gas finders fraternity enthusiastically following an axiom recently propounded by A. I. Leverson, prominent contemporary geologist, relative to eventual success in the search for new fields. He states, "Exploration for oil and gas is simple and may be summed up in six words. Find a trap and drill it!"

Arizona, the "baby state" of the Union (1912) is also the baby state in the oil industry, having been admitted into that enviable category in August, 1954, thereby becoming the thirtieth state to have developed commercial oil and gas within its boundaries.

The state of Arizona probably has had, and in some degree continues to have, more mental strikes against it than any other marginal or semi-proven state.

In the past, the lack of markets, the isolated and inaccessible character of some of the most promising areas, the lack of the application of intelligent geology, the high percentage of speculative and promotional ventures (many of which were based on complete absence of geological study), lack of water, and the relative high cost of drilling and exploration in relation to other undeveloped areas, have obviously retarded oil and gas development in this state.

Most, if not all, of the above deterrent factors relative to exploration have been eliminated or their degree of importance has been considerably minimized.

The first well drilled for oil and gas of record in Arizona was drilled in 1903 in Yavapai County to a depth of approximately 2000 feet. Since that time, approximately 107 wells have been drilled as a matter of record in the state, the great percentage of which can be disregarded due to the fact that they were extremely shallow tests or strictly promotional ventures lacking any geological control.

In the most promising part of Arizona—the northern one-third; lying between the 35th and 37th parallels and constituting some 40,000 square miles—only 18 wells have been drilled and only 9 of these reached a depth greater than 3000 feet. Three of these 18 tests were completed as commercial oil and gas wells within the last 18 months. These 18 tests constitute a wildcat spacing pattern of only one well for every 2000 square miles, and this meager exploration program has resulted in a lack of subsurface geological knowledge considered so highly essential by the profession today in planning a drilling program in a relatively unknown area.

Present Exploration. At the present writing, the oil and gas development situation in Arizona is considerably changed. That a great deal of the negative geological thinking is being reversed, is indicated by the present

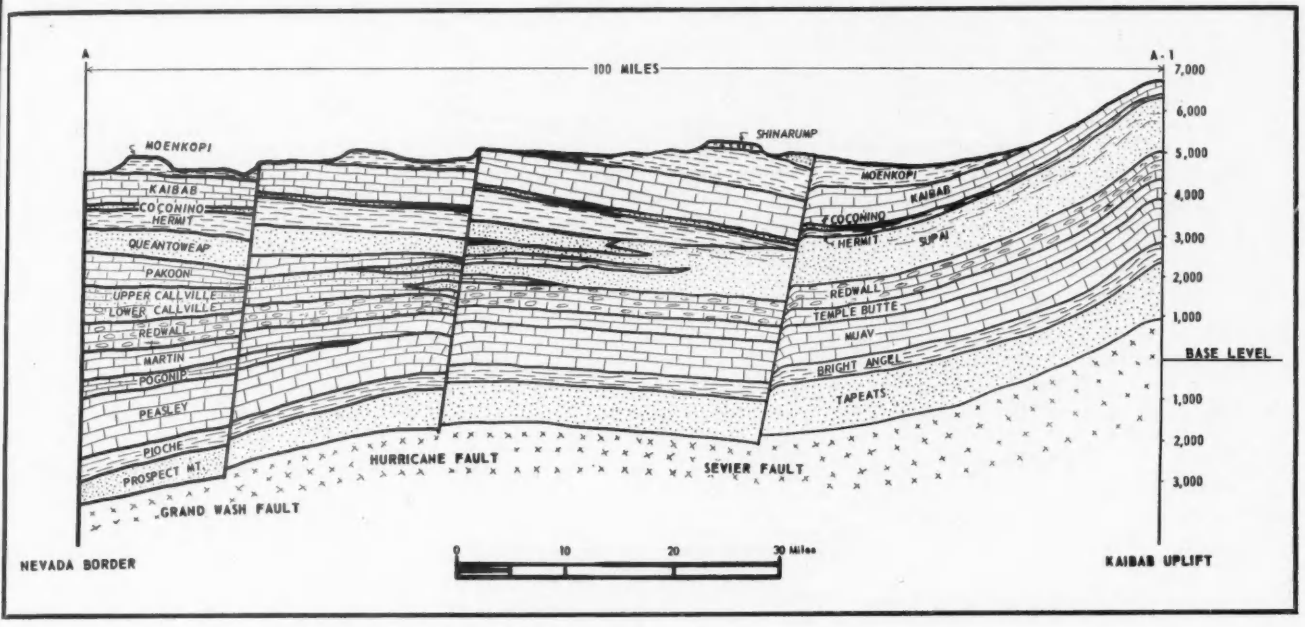


FIGURE 2—Cross-section northwestern Arizona as indicated on Figure 1.

drilling exploration program being carried out, and by the geological, geophysical, and leasing projects now planned or in actual operation by the independents and major companies.

The discovery well in the state is generally considered to be the Shell Oil Company No. East Boundary Butte, located in Sec. 6, T-41-N, R-28-E, Apache County, which was completed in March, 1954, and produced from the Hermosa formation at approximately 4650 feet at a rate of 250,000 cubic feet per day. Shell's offset to this well, East Boundary Butte 2, located in Sec. 3, T-41-N, R-28-E and to the east of discovery well was completed for 2½ million cubic feet of natural gas and 30 barrels of oil per day, from the Hermosa formation at 4600-4700 feet. Humble Oil & Refining Company then completed the Navajo-Tribal well in Sec. 4, T-41-N, R-28-E, which was brought in for a potential of 4½ million cubic feet of gas and 68 barrels of 32 gravity crude oil per day. This well also made a commercial oil drill stem test from the Mississippi lime at around 5400 feet.

Due to the fact that no gas or oil pipe line connections have been made to these wells at this time, offset development has been slow; however, the Hancock Oil and Gas Company is now drilling a 6500-foot test offsetting Humble to the south in Sec. 29, T-41-N, R-27-E, and the Franco-Western Oil Company of Bakersfield, Calif., is drilling a 6000-foot test in Sec. 22, T-41-N, R-28-E. El Paso Natural Gas has four core rigs drilling stratigraphic tests in the same area and plan a deep test in the near future. Successful completion of the present exploratory tests should result in both oil and gas pipe line outlets to the first Arizona oil and gas field. With the establishment of these outlets many offset wells will be required and exploration will be greatly accelerated.

In northwestern Arizona, the Falcon-Seaboard-Valen Oil Company's Government 1 is drilling a 5000-foot test in Sec. 28, T-38-N, R-8-W, Mohave County. This is the first test to be drilled in Northwestern Arizona, an area embracing some 8000 square miles of a yet untested geologic province having definite oil and gas possibilities.

Future. Some 6 million acres of land is under federal, state and fee lease in Arizona for oil and gas at this time, and the industry can look for a much more intelligent and concentrated effort to develop the potentialities of the state during the coming years.

Geological Analysis and Future Possibilities. The obvious way to properly evaluate the oil and gas future of Arizona would be to divide it, for purposes of clarity of discussion, into four quadrants, viz: the Northwest, Northeast, Southeast and Southwest quarters of the state as indicated in Figure 1.

The north half of the state is well separated geologically. This separation is effected by following the trend of the Kaibab Uplift from the Utah state line on the north, and continuing generally south to the Mogollon Rim on the south. Therefore, the Northeast quadrant is constituted by the Black Mesa Basin and the Northwest quadrant is constituted by a southeast segment of the Great Basin.

Dividing the south half of the state into two separate quadrants will be more for convenience in discussion than for any geologic or geographic reason.

Northwest Arizona. The northwest portion of the state is represented largely by a Paleozoic section of sedimentary beds which were deposited in

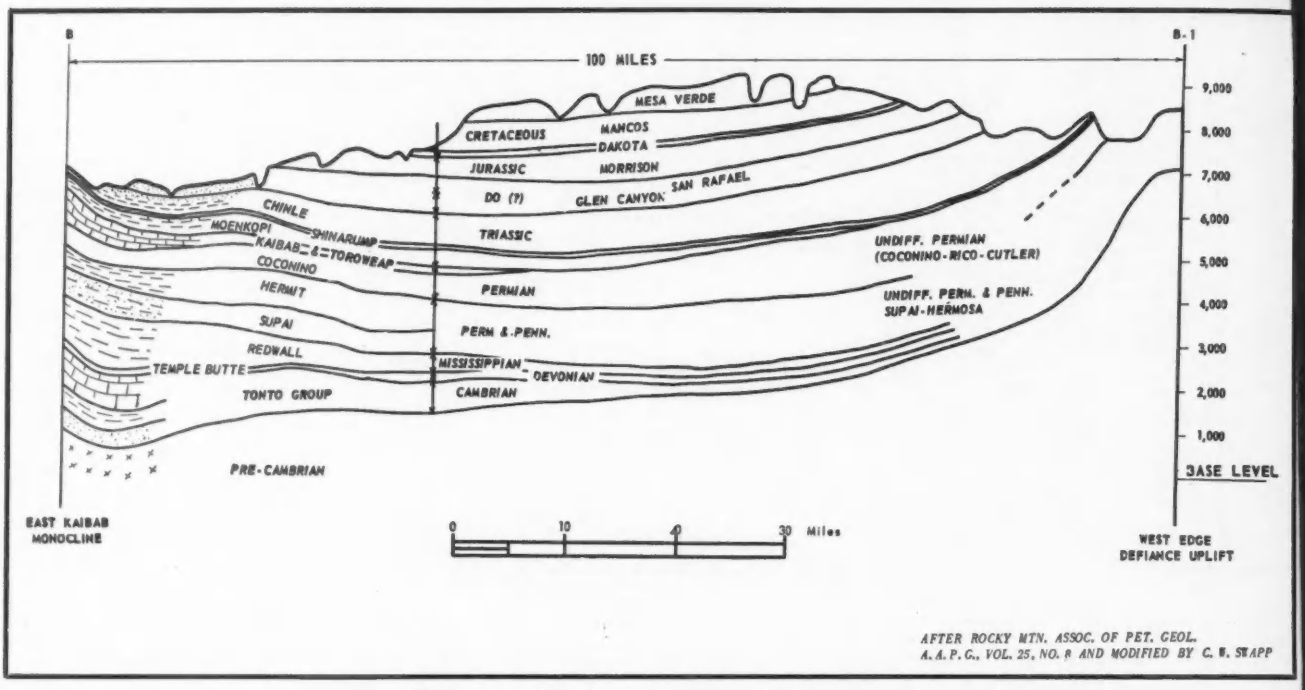


FIGURE 3—Cross-section Black Mesa Basin as indicated on Figure 1.

southeast part of the Great Basin. Figure 2 represents an East-West cross-section (A-A[1]) of this area. Due to the absence of deep exploratory drill holes from which to gain information, the author has taken liberty to generalize on such information as is available to conform with an interpretation of the stratigraphic and structural conditions.

• **Structure**—Major structural features of this area are the Grand Canyon or Kaibab Uplift to the south and west, and three major north trending high angle faults which divide the province into plateaus. The Colorado River separates the Coconino Plateau on the south from the Shivwits, Uikaret, Kanab and Kaibab plateaus on the north. In addition to this, there are numerous minor faults and foldings.

It has long been the opinion of some geologists that this portion of the Great Basin is not favorable for the accumulation of oil and gas due to the section being cut by the Grand Canyon. In view of the following, it is thought that this criticism is unfounded.

The primary objective in locating drill sites in a new area would be where there is evident structural control. This type control can be found along the major fault zones due to nosing and in numerous, low anticlinal folds, which appear to be associated with the faulting.

A very important item at this point is to establish the fact that the control was in place during or previous to the cutting of the Paleozoic section by the Colorado River. The earliest time that this chasm could have been cut has been established by C. R. Longwell[1] as being Pliocene or later. The exact timing on the structural control has not been so well established, but it is generally recognized that much of the movement on the major fault zones occurred pre-Grand Canyon and contemporaneous with the regional uplift of the Kaibab.

Gregory[2] says, "The field evidence leads to the conclusion that the greater part of the displacement along the major faults was accomplished before, rather than after, the great denudation." He is of the opinion that the antiquity of the first movements on these faults is reflected by areas such as that between Alton and Glendale in Utah along the Sevier fault and also south of Pipe Spring in Arizona. These zones show little or no escarpment along the fault, indicating long periods of erosion since the movement. In other areas of the faulting, well-defined escarpments are in evidence of some movement at a later date.

• **Stratigraphy**—Every period of the Paleozoic era, except the Silurian, has representation in this part of the state. The Ordovician (?), however, is limited to the northwest portion.

The thickness of the section ranges from about 7500 feet near the Nevada border in the northwest to approximately 5500 feet along the Grand Canyon to the southeast.

In addition to the Paleozoic sections, there are limited outcrops of Triassic and Jurassic age along the extreme north and west borders of the state. The only portion of these Mesozoic beds considered to be of any importance, oil and gas-wise, in the area would be the basal lime and sandstone members of the Moenkopi. These members are known to be petroliferous in numerous outcrops in southwest Utah and northwest Arizona. It is a portion of these zones which provides the immediate source of the production in the Virgin oil field 15 miles north of the Arizona line in Utah.

Permian and Pennsylvanian sections are represented by limestones, sandstones, shales and dolomites with considerable intertonguing which is typical of the transgressive and re-

gressive phases of a shore line profile. These formations have numerous zones which could serve as source and reservoir beds for oil and gas accumulation. In addition, they show numerous possibilities of stratigraphic traps.

Mississippian Redwall limestone and its western equivalent, the Rogers Spring, is one of the more consistent and outstanding formations in the section. It has become more important in recent years due to its encouraging oil indications in south central Utah and northeast Arizona.

The Muddy Peak limestone along the Nevada border and its eastern equivalent, the Martin Limestone, represents the Devonian Period in the section. The Temple Butte formation, also of Devonian age, and generally correlated with the above formations, extends from the Grand Canyon north into Utah.

Ordovician Pogonip (?) formation is shown by McNair[3] as being 216 feet thick along the eastern border of Nevada. These beds apparently pinch out to the south and west as they are not represented in the Hurricane Cliffs or the South Grand Wash Cliffs in Arizona.

The Cambrian section is comprised generally of three formations with a total thickness of approximately 2200 feet in the northwest and thinning completely out at Jerome, Arizona, in the southeast. The Tapeats sandstone is the oldest Cambrian formation and is overlain by the Bright Angel shale and the Muav limestone. The Tapeats sandstone has also had oil shows in a well drilled along the east flank of the Kaibab Uplift in Coconino County, northeast Arizona. (See Figure 4 for nomenclature of Arizona stratigraphy.)

• **Summary—Northwestern Arizona**—The basic factors which are normally considered requisite for oil and gas accumulation, viz: source beds, reservoir beds, structural conditions, and the all-important structural timing vs. migration period, are present in this section of the state. A drilling exploration program is warranted wherever local surface structural control is favorable.

Northeast Arizona. The northeast quadrant of the state is almost entirely consumed by the large structural feature commonly known as the Black Mesa Basin. U. S. Highway 66 traverses the Basin east to west, crossing the southern part via Holbrook, Winslow and Flagstaff and U. S. Highway 89 extends north along the east Kaibab monocline, branching off of Highway 66 near Flagstaff. Numerous access roads lead from these two main lines into other areas of the basin.

• **Structure**—Although commercial oil and gas production has now been established in this quarter of the state, as outlined above under "Present Exploration," there is considerable geologic information yet to be obtained before the structural or stratigraphic nature of this basin will be clearly understood. The area is well delineated by the Monument Uplift to the north; the Zuni and Defiance uplifts to the east; the Navajo arch to the south, and the Kaibab Uplift on the west.

In view of the data available, it is apparent that the area was a shore line or shallow shelf zone of the Great Basin to the northwest during parts of Cambrian, Devonian, and Mississippian times. There were considerable environmental changes in the area during Pennsylvanian and Permian times, as indicated by the appearance of thick sections of continental and evaporite beds in these time zones. These changes were probably affected by an active area along the trend of the present Kaibab Uplift in combination with others to the north and south and by the well-established Defiance high to the east, which factors isolated this portion of the inland seas.

Occurrence of igneous activity in the form of explosive vents, dykes and flows is known in the Hopi volcanic field near the south central portion of the basin. The nature of these features has been discussed by Hager[4,5] and are considered to have little if any effect on the possibilities of oil and gas accumulation in the area.

Present day surface structural features of importance in the Black Mesa Basin include a number of low anticlinal folds along the shallower parts of the basin. Also, there are several known structural highs in the central part in addition to many which undoubtedly have not been recognized or mapped, due to the limited amount of reconnaissance work done in the area. Both surface geology and seismic surveys were employed for structural determination of the discovery field, and both methods will undoubtedly continue to be applied to the exploration of this vast area.

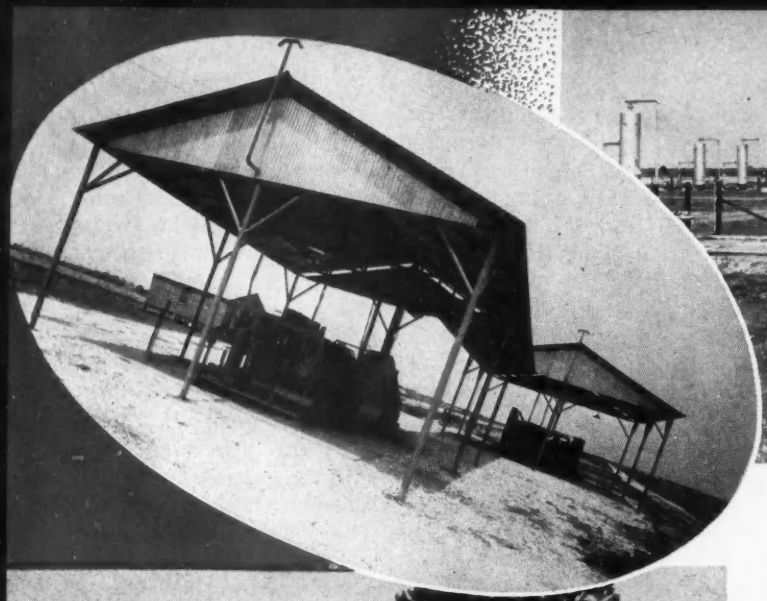
• **Stratigraphy**—The Cambrian, Devonian, and Mississippian periods are represented in this area largely by sediments of marine deposition which increase in thickness toward the northwest. Due to the very limited number of wells drilled to these lower zones in the basin area, little is known of their nature. The combined thickness of sediments encountered of these ages was approximately 600 feet in the Amerada and Stanolind well in the east central part of the basin. Seventy miles west of this, and on the west edge of the basin, the Collins-Cobb test penetrated 1400 feet of sediments of the above systems.

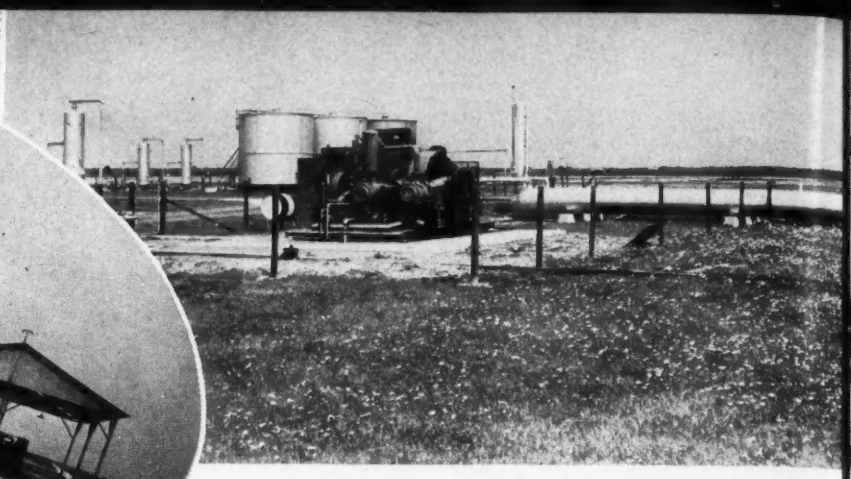
Formations laid down during the Pennsylvanian and Permian periods are more complex than those of lower Paleozoic age. These beds, as previously stated, contain large amounts of continental sediments and some evaporites. In addition, there are numerous limestone and dolomite beds present.

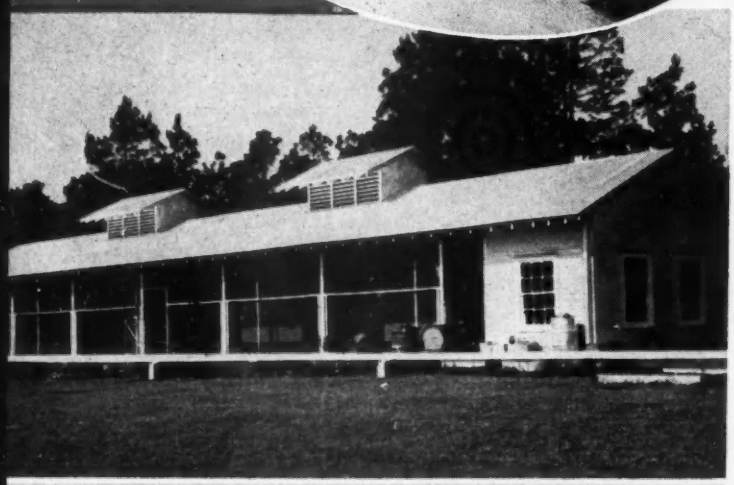
From well log information available, it is shown that the combined Pennsylvanian-Permian section is approximately 600 feet thicker in the east central part of the basin than they are in the west central part. This would indicate possibilities for stratigraphic oil and gas traps, especially along the flanks of the basin.

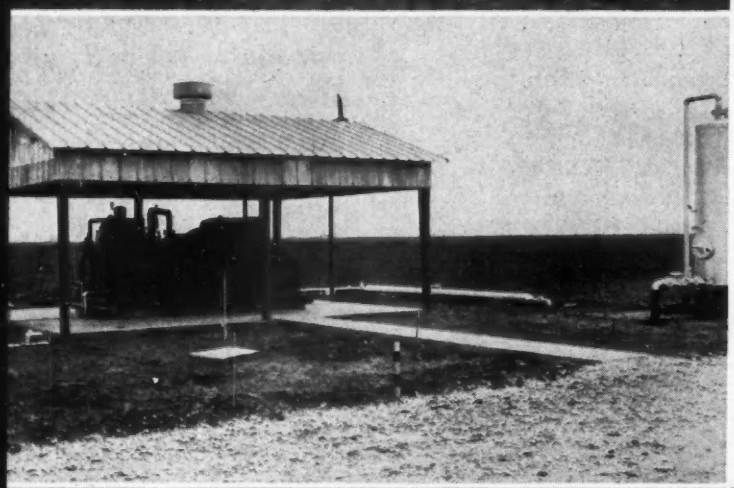
As shown in Figure 3, cross-section (B-B[1]) there are thick sections of Mesozoic age in the central portion of the Black Mesa Basin. The Triassic beds offer some possibilities of production, but it is doubtful that those of Jurasic and Cretaceous age occur in satisfactory relation to structure or have sufficient depth to be petroliferous.

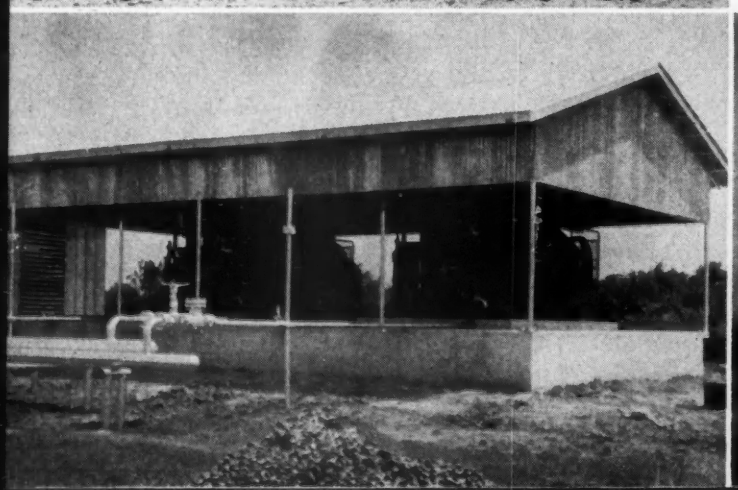
• **Source and Reservoir Beds**—There are numerous organic shales or limestones present in each of the periods represented in this area. A number of these have shows of oil or gas in tests already made in addition to the pro-

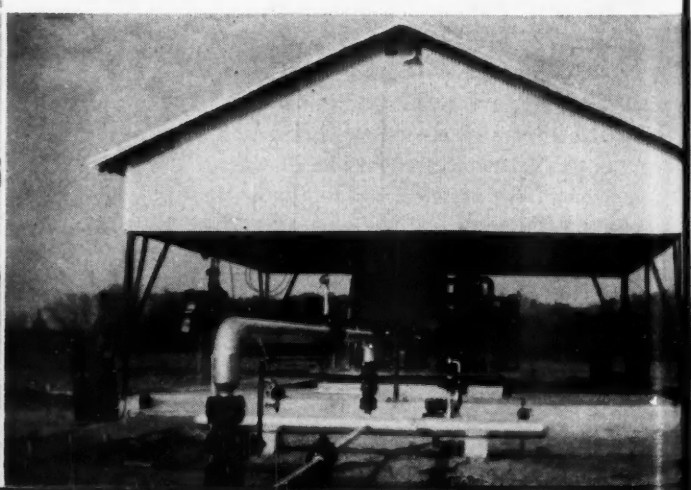












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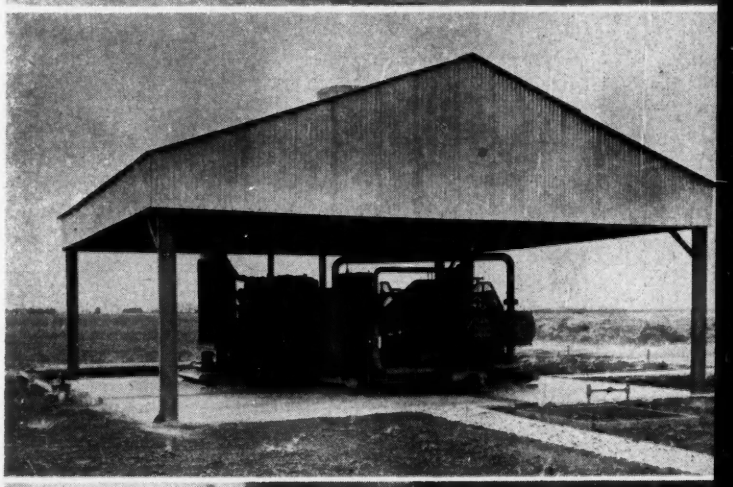

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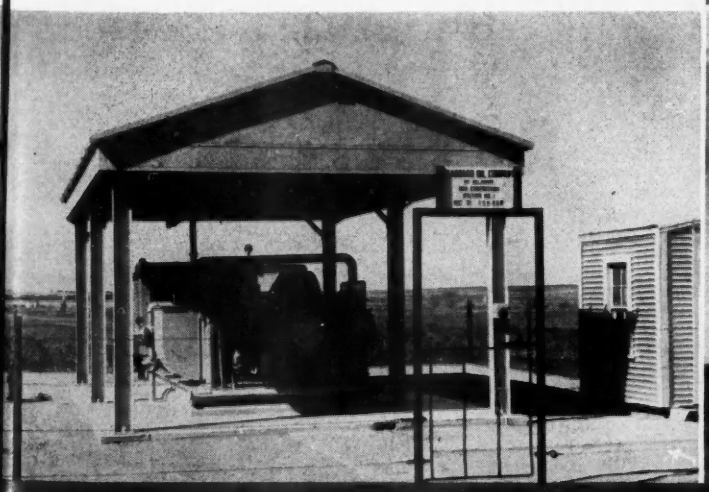

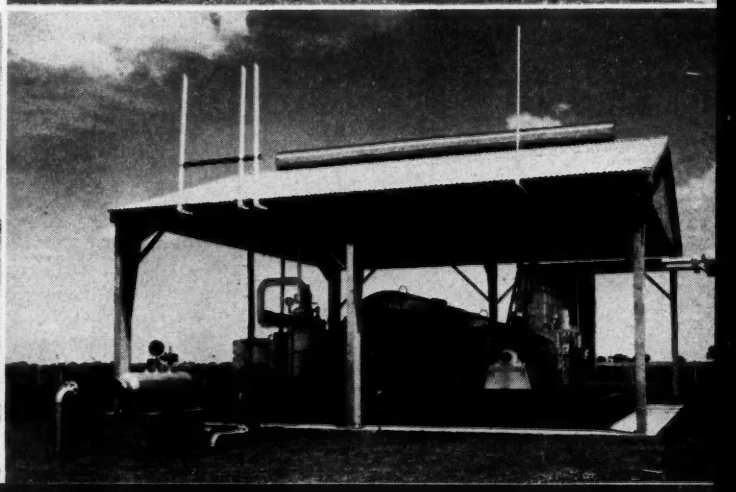

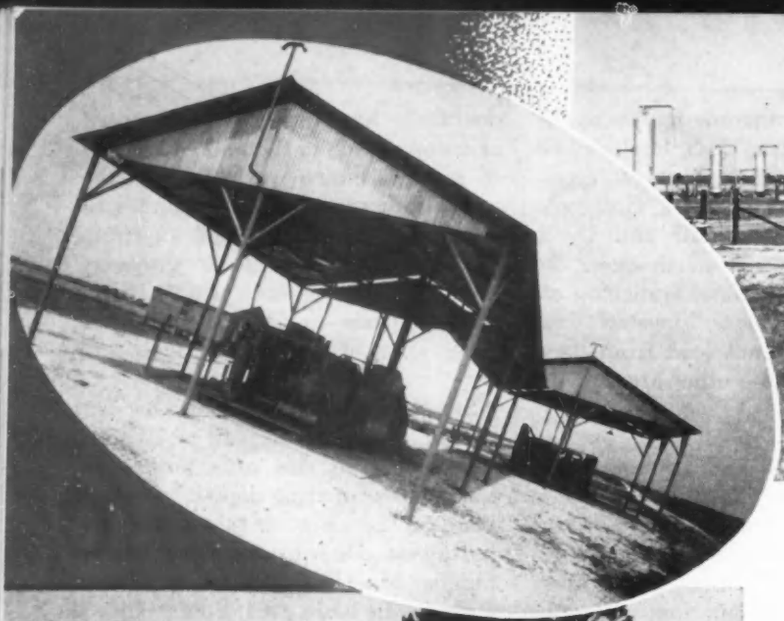

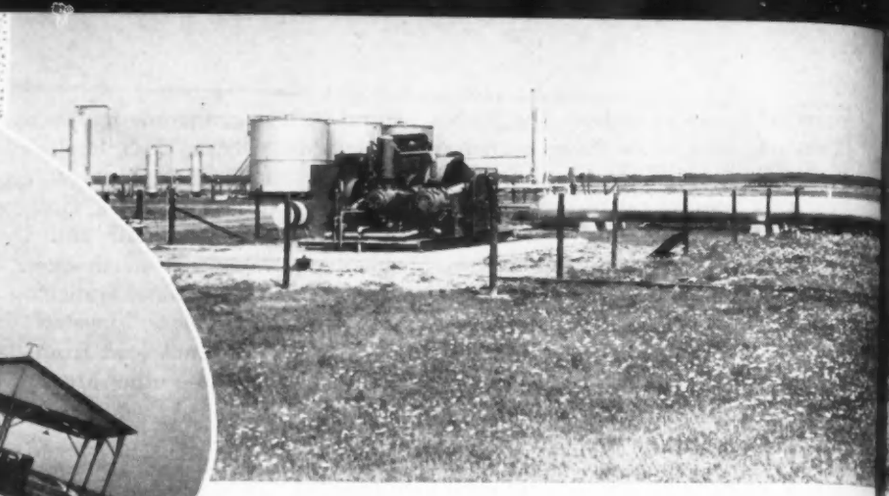

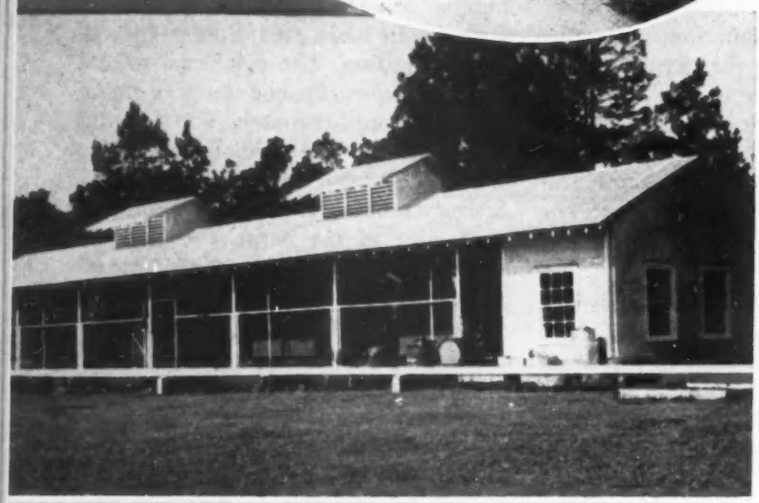

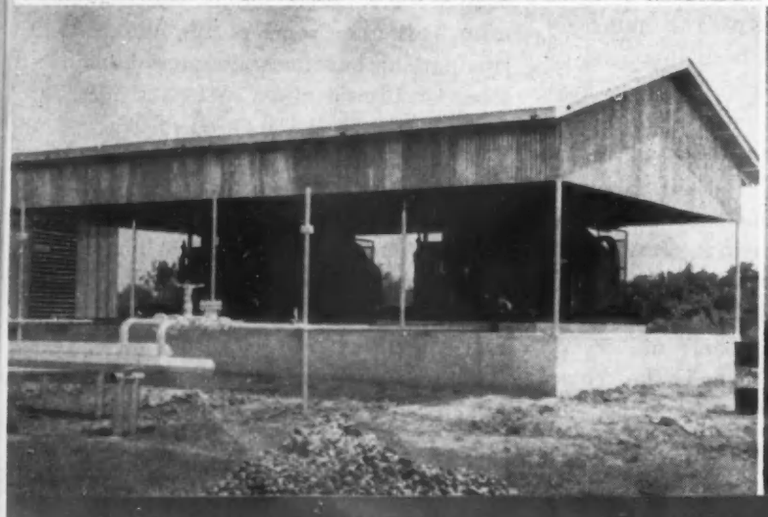

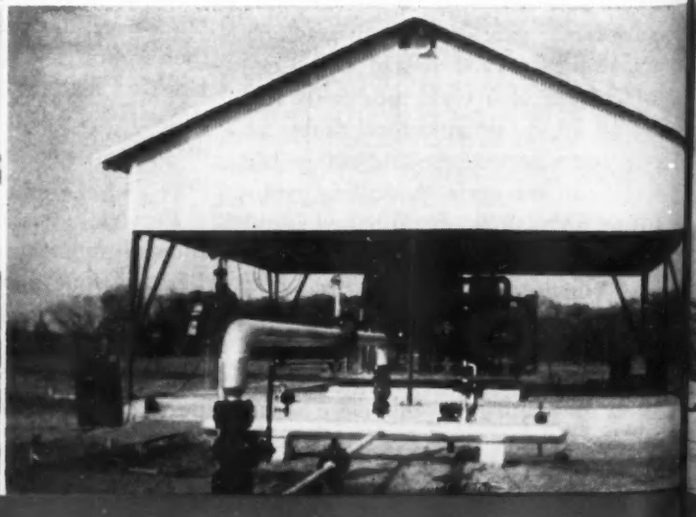

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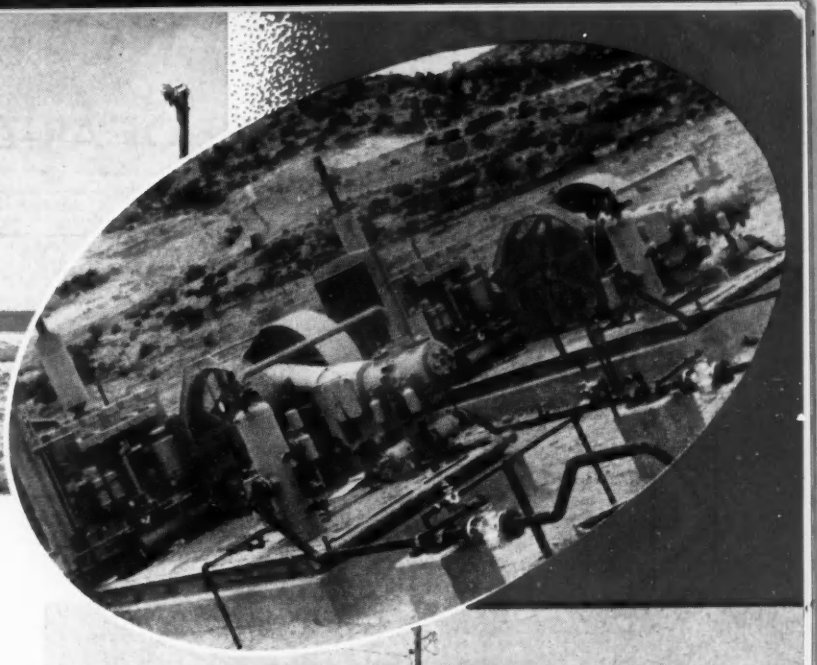

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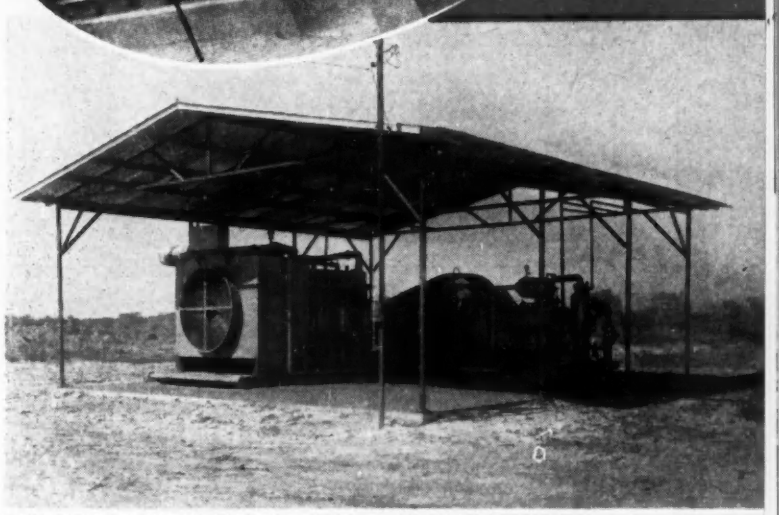

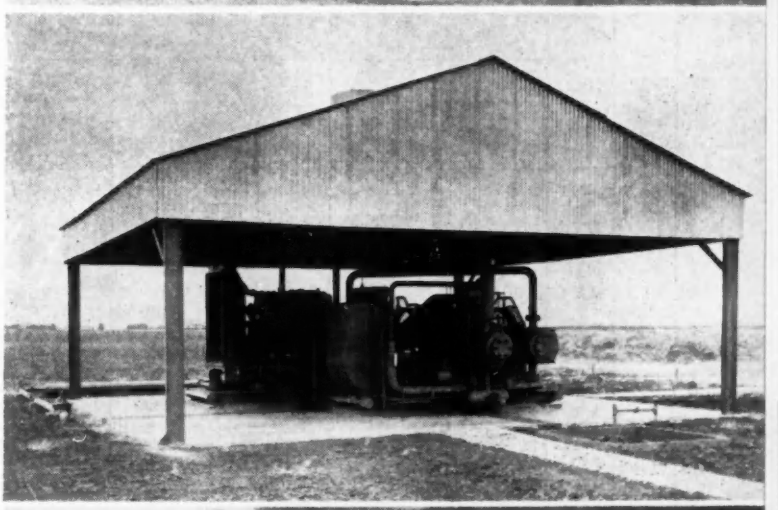

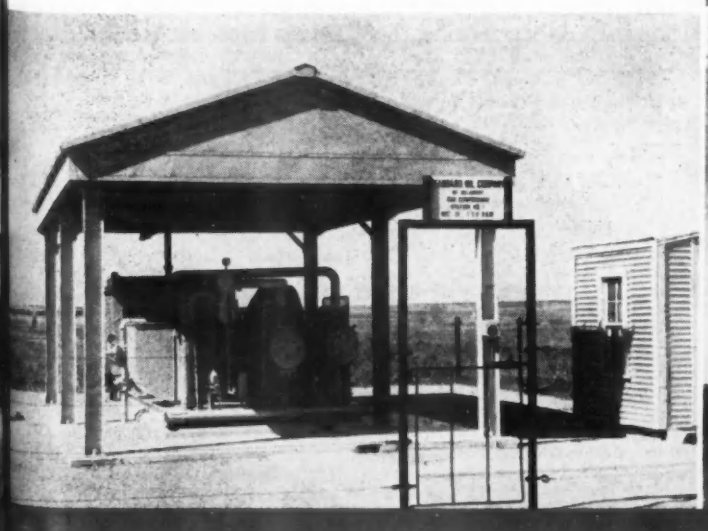

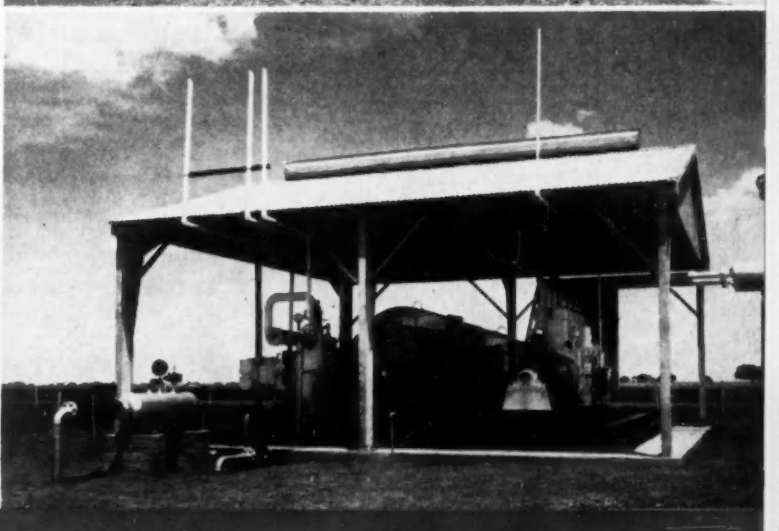

NOMENCLATURE OF ARIZONA STRATIGRAPHY

		NORTHWESTERN	NORTHEASTERN	SOUTHEASTERN	SOUTHWESTERN	REMARKS
REFERENCE		GREGORY McKEE McNAIR	GREGORY HAGER HOLM	STOYANOW	McKEE - TAKEN FROM ISOPACH MAPS AND USING S.E. ARIZONA NOMENCLATURE	
CENOZOIC	QUAT. SYSTEM					
	TER.		BIDAHOCHI			
MESOZOIC	CRETACEOUS UPPER		MESA VERDE MANCOS DAKOTA	UNNAMED (FORT CRITTENDEN FM. SONOITA GP. ((FORT BUCHANAN FM (FORT BUCHANAN FM.	SONOITA GROUP	OIL FROM DAKOTA IN NORTHWEST NEW MEXICO
	CRETACEOUS LOWER		MORRISON	PATAGONIA GP. - MOLLY GIBSON FM. (CINTORA FM. (MURAL FM. BISBEE GP. (LOWELL FM. (MORITA FM. (GLANCE CONG.	PATAGONIA GROUP BISBEE GROUP	
	JURASSIC	CARMEL FM. GLEN CANYON GP.	(CURTISS (TODILTE SAN RAFEL GP. (ENTRADA (CARMEL (NAVAJO GLEN CANYON GP. (KAYENTA (WINGATE			
	TRIASSIC	CHINLE SHINARUMP MOENKOPI	CHINLE SHINARUMP MOENKOPI			TIMPOWEAP MEMBER OF MOENKOPI PRODUCES IN VIRGIN OIL FIELD 15 MILES NORTH OF ARIZONA LINE IN S. W. UTAH
PALEOZOIC	PERMIAN	KAIBAB LS. TOROWEAP FM. COCONINO SS. HERMIT FM. U. SUPAI — QUEANTOWEAP PAKOON LS.	KAIBAB TOROWEAP COCONINO SS. HERMIT SH. DeCHELLY SS. SUPAI FM. ALSO FM.	CHIRICAHUA LS. SNYDER HILL FM. FOSSILIFEROUS LS. AND QTZITE MANZANA FAUNA GYPSUM BEDS	UNDIFFERENTIATED 900 - 2000 (?)	OIL SHOWS IN KAIBAB IN SO. UTAH (GARFIELD & KANE COUNTY) HELIUM IN SO. APACHE CO., N. E. ARIZONA (COCONINO)
	PENN.	U. CALLVILLE L. SUPAI L. CALLVILLE	HERMOSA - NORTH NACO - SOUTH	GALIURO LS. NACO LS.	GALIURO LS. NACO LS.	OIL AND GAS PRODUCTION IN NORTHEAST ARIZONA
	MISS.	REDWALL LS.	REDWALL LS.	PARADISE FM. ESCABROSA LS.	PARADISE FM. ESCABROSA LS.	OIL AND GAS FROM HUMBLE OIL CO'S NAVAJO NO. 1 IN N. E. ARIZONA, 500 BBL. PER DAY OIL IN SO. UTAH - CAL. CO. (UPPER VALLEY)
	DEVONIAN	MARTIN - SOUTH TEMPLE BUTTE - NORTH	MARTIN - SOUTH TEMPLE BUTTE - NORTH	LOWER OURAY FM. MARTIN LS. PICACHO DE CALERO FM.	LOWER OURAY FM. MARTIN LS. PICACHO DE CALERO FM.	PETRILIFEROUS IN S. E. UTAH - SHELL OIL CO. BLUFF NO. 1. MUCH GREEN WAVY SHALES IN E. J. PICKETT NO. 1 OF S. W. UTAH.
	SILVRIAN					
	ORDIVICIAN	POGONIP (?)				
	CAMBRIAN	DOLO. LS. - UNNAMED PEASLEY SH. LYNDON LS. PIOCHE SH. PROSPECT MT. QTZITE.	MUAVE LS. BRIGHT ANGEL SH. TAPEATS SS.	PEPPER- SAUCE CANYON SS. RINCON LS. COPPER QUEEN LS. ABRIGO FM. SOUTHERN BELLE QTZITE / SANTA CATALINA FM. — COCHISE FM. / PIMA S. TROY QTZITE — BOLSA QTZITE	UNDIFFERENTIATED 0 - 1000'	OIL SHOWS IN TAPEATS SS. IN NORTH CENTRAL ARIZONA
			PRE-CAMBRIAN			COMPILED BY C. B. SHAPP - MAY, 1956

FIGURE 4.

duction mentioned in other sections of this article.

Sections containing beds of high porosity and permeability, which could well serve as reservoirs for oil and gas accumulation, are present in numerous zones of both the Paleozoic and lower Mesozoic eras.

• **Conclusion—Northeastern Arizona**—A large leasing and continuous exploration program in this part of Arizona has been initiated and will be accelerated in the future. Since the northern three-fourths of the Black Mesa Basin is entirely composed of the Navajo and Hopi Indian Reservation lands, the control of exploration

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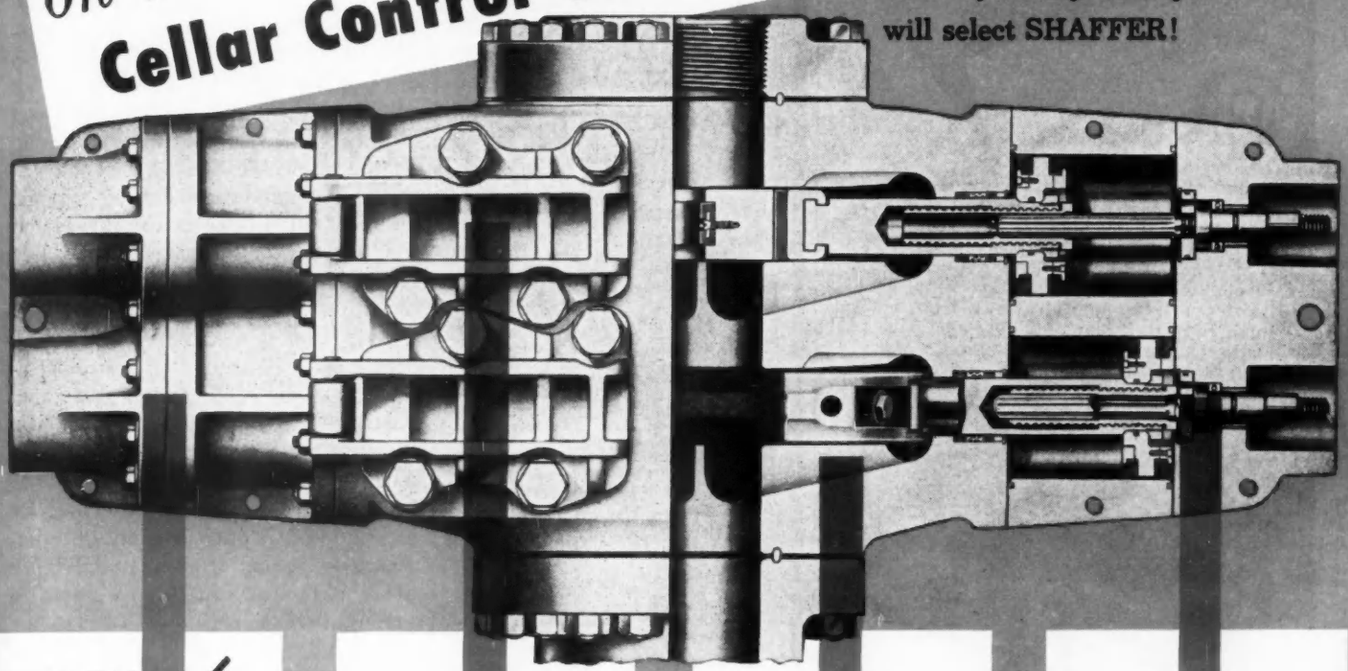

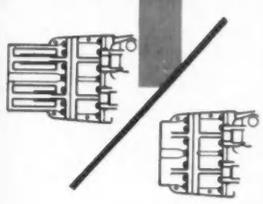

Rising or Non-Rising Stem

Some operators like the extra compactness of a non-rising stem on the locking screw—others prefer the quick indication of ram position afforded by a rising stem. Take your choice—Shaffer, and **only** Shaffer—provides your choice of whichever design **you** prefer. Note that built-in body extensions guard each stem in all positions. The stem—whether rising or non-rising—is never exposed beyond the body where it might become bent or damaged.

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To change rams in Shaffer Hydraulic Gates you simply unbolt and swing open two side doors, slide out the ram assembly, change rams, replace the assembly and bolt the doors. Closing the doors automatically aligns the rams within the gate body. And whether pipe is in or out of the hole, rams in **either** compartment can be changed with equal ease. There's no need to dismantle the upper compartment to change rams in the lower compartment—or vice versa!

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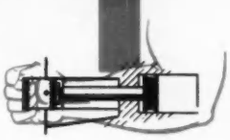

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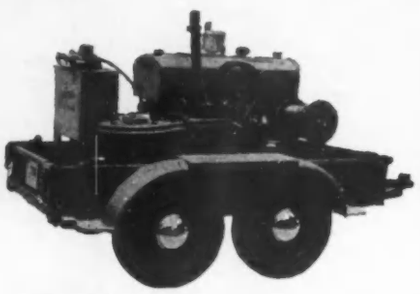

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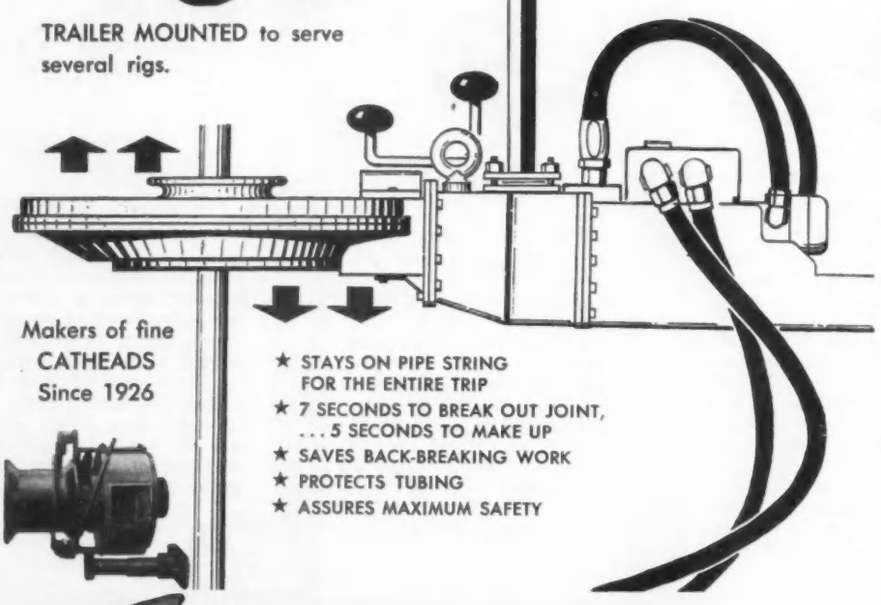

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and development in this area will be directly related to the action of the Tribal council of these tribes and to the sale of leases, and regulation by the Bureau of Indian Affairs.

Oil activity in some of the most geologically interesting part of the basin has been stalemated for years due to a boundary dispute between the Hopis in the central part of the basin, and the Navajos, whose reservation surrounds them on all sides. This dispute will have to be settled by an act of the U. S. Congress, which will require considerable time. However, on the favorable side of the ledger is the recent announcement by a large, independent oil operator in Dallas that several million acres in this area have been leased for oil and gas exploration directly from the Navajo Tribal council. Competitive bids will continue to be requested by oil companies on desirable acreage in other parts of the Navajo Reservation through the Bureau of Indian Affairs. The south one-fourth of the Black Mesa Basin is federal, state and fee acreage and is open for any oil operator, there being an estimated 400,000 acres under lease in this specific area alone, at this time.

Southeast Arizona. This portion of the state consists largely of scattered mountain ranges, generally having a north to northwest trend with broad intermountain valleys. Some of these ranges are comprised almost entirely of igneous and metamorphic rocks while others have great thicknesses of Paleozoic and Cretaceous sediments.

The valleys in most instances contain thick accumulations of alluvial material, which is a detriment in defining structural control in the sections below. This valley fill has been found in some cases to be as much as 4000 to 6000 feet thick.

In examining the section northwest of Tombstone and also in Rucker Canyon, northeast of Douglas, it was found that these formations contain numerous zones which could very well serve as reservoir beds for oil and gas accumulation. In addition, there are excellent sections containing dark gray to black carbonaceous shales which could well serve as source beds.

Near Willcox in one of the large intermountain valleys there are a number of oil seepages. Some of the

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About the Author

CLOYD W. SWAPP, chief geologist for the Valen Oil and Minerals Corporation, was graduated from Utah State Agriculture College in 1951 with a BS degree in geology. After two years of mining and petroleum consulting work in southern Utah and northern Arizona, he assisted in the formation of the Valen Oil and Minerals Corporation, headquartered in Phoenix, Arizona.

water wells drilled in this area were abandoned due to oil contamination and it has been reported that several hundred barrels of this oil was pumped from the surface of the water and sold for use as automobile fuel between 1928 and 1938.

The large alluvial filled valleys offer more of a challenge. It is considered quite possible, however, that there are favorable structural traps in and along the edges of these valleys, but it will take considerable geological and geophysical work plus some positive geologic thinking to determine the procedure most adaptable to the mapping of each particular area. As, and when this mapping is completed only an intelligent drilling program will give the final answers.

The presence of reservoir beds, source beds and surface indications are indicated in parts of southeast Arizona. In the less structurally disturbed areas several anomalies have been observed, a few of which have been mapped and these offer favorable areas for exploration.

Southwest Arizona. Geological conditions in this section of the state are similar in many respects to those of the southeast quadrant. The mountain ranges are largely igneous with some remnants of Cretaceous and Tertiary beds outcropping along the ridges. The extensive intermountain valleys contain thick accumulations of valley fill which, as mentioned previously, would be a detriment to locating possible oil and gas structures. The thickness of the sedimentary sections to be expected in the area is not known but is probably much less than in the southeast. A series of step faults having a general northwest-southeast trend and paralleling the mountain ranges in the area could form effective traps for oil and gas accumulation.

Development of this area will depend largely upon effective geophysical and geological interpretation of the unusually adverse conditions present.

Drilling Conditions. Considering the entire state of Arizona, the exploratory drilling problems are no different, nor any more expensive than in similar areas throughout the Rocky Mountain region. No exceptional conditions were encountered in drilling the Shell and Humble discovery wells in the northeast corner. By the selection of proper size and type of equipment for drilling to the projected maximum depths this situation should prevail throughout the state. In exceptional cases of excessive lost circulation, particularly in an area short on water, operators are converting to air equipment and experiencing no difficulty.

Cable tools and/or air will be seriously considered, particularly in the completion of many exploratory wells, due to subnormal reservoir pressures known or expected to exist in many areas of the state.

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	Formation	R_i	R_s	R_t/R_i	D_i/d
Thick beds	All types	5 to 100		Wtr. bearing 1/10	2, 5, 10
				Oil bearing 2	2, 5, 10
Thin beds e = 80"	Soft	5 to 50	1	Wtr. bearing 1/20	2, 4.22, 8.66
				Oil bearing 1	
	Hard	20 to 100	100	Wtr. bearing 1/10	2, 4.22, 8.66
			1000	Oil bearing 2	2, 4.22, 8.66

FIGURE 1—These are the values selected for the various factors. Hole diameter is 8 inches and $R_m = 1$. The values of R_i/R_m give a rough order of magnitude of the values of the formation factor.

How do the various logging devices compare when . . .

Determining True Resistivity

The 40-inch induction log appears to be the most efficient, since it gives a reading approximately R_t in the greatest number of cases.

By MAURICE MARTIN
and **J. L. DUMANOIR**
Schlumberger Well Surveying Corporation
Richfield, Conn.

THE RELATIVE performances of the various resistivity measuring devices in picking beds and defining their boundaries are well known.

Not so well known, however, are their relative abilities to give values approximating true formation resistivities. True resistivity, (R_t), is essential for the determination of water saturation in a given reservoir.

The efficiencies of the logging devices in reading R_t cannot be determined completely and accurately from log analysis alone, because some of the factors affecting the readings are generally unknown, or inaccurately known; (the depth of invasion, for example).

Accordingly, the efficiencies of the various devices (normals, lateral, laterolog, induction log) were investigated by computations and laboratory tests.

For purposes of comparison, the factor of efficiency used was the ratio: R_a/R_t; the ratio of the apparent resistivity recorded by a particular device for a given set of conditions of bed thickness, invasion, etc., to the true resistivity of the formation.

Conditions of the Investigation

1. It was assumed as usual that the bed under consideration is bounded by plane interfaces, and that the invaded zone is a homogeneous medium limited by a cylindrical surface coaxial with the borehole.

The parameters involved in this investigation, and the devices studied, are listed below with their respective symbols:

apparent resistivity	R_a
true resistivity	R_t
resistivity of invaded zone	R_i
mud resistivity	R_m
resistivity of adjacent formations	R_s
hole diameter	d

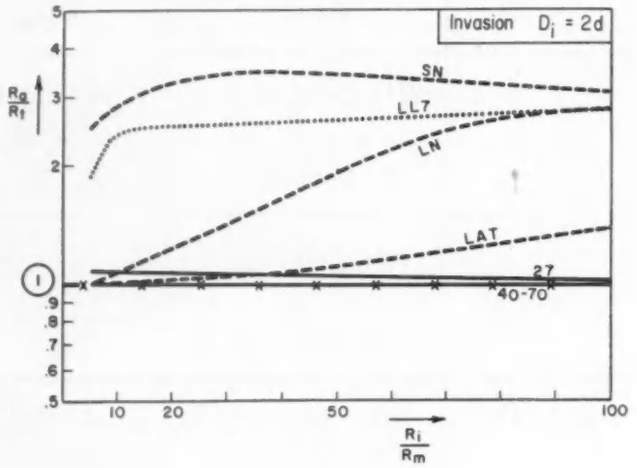


FIGURE 2

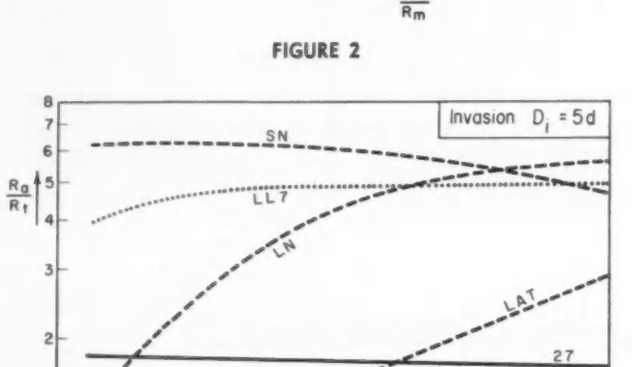


FIGURE 3

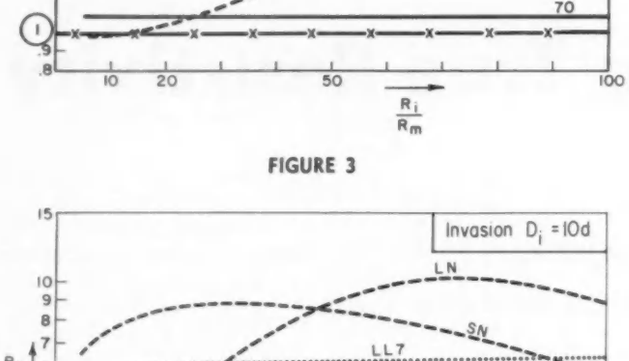


FIGURE 4

d = 8 inches; $R_t = \frac{1}{10} R_i$. Note that the efficiency of all induction logging devices decreases as invasion increases. Efficiency usually improves with increased spacing.

diameter of invaded zone			D_i
bed thickness			e
Short normal	(16″)		SN
Long normal	(64″)		LN
Lateral	(18′ 8″)		Lat
Laterolog	(32″)		LL-7
Induction log:		27″*	27
Induction log:		40″	40
Induction log:		70″	70

* (The figures 27″, 40″, 70″ designate the "spacings," i.e., the distances between the main coils. A description of the induction logging method can be found in H. G. Doll's paper on "Introduction to Induction Logging and Application to Logging of Wells Drilled with Oil Base Mud"—Petr. Techn.—Vol. 1, No. 6, June 1949.)

(The 5-FF-70″ sonde is a device still in the experimental stage.)

2. The response of each device (i.e. the apparent resistivity at the level of the bed under consideration), was determined for thick and thin beds, for soft formations (high porosity), and hard formations (low porosity), for water bearing and oil bearing beds, and for different depths of invasion.

The values selected for the various factors involved are shown on Figure 1. The hole diameter is taken equal to 8 inches and the mud resistivity R_m as unity. The values of R_i/R_m give a rough order of magnitude of the values of the formation factor.

(a) For *thick beds* R_i/R_m varies from 5 to 100, which covers a wide range of practical values of the formation factor. The resistivity of the water bearing formations is equal to $R_i/10$. The resistivity of the oil bearing formations is 2 R_i, which, by comparison with the water bearing zones, corresponds to 22 percent water saturation. The diameters of invasion are respectively equal to 2d, 5d and 10d.

(b) The *thin beds* are 80 inches in thickness or 10 times the hole diameter. The case of soft formations corresponds to values of R_i/R_m ranging from 5 to 50. In this case, R_s is taken equal to R_m. For the water sands R_t is equal to $R_i/20$. The oil sands have a resistivity $R_t = R_i$ (22 percent water saturation).

For hard formations, the value of R_i/R_m ranges from 20 to 100 and the adjacent formations are either 100 or 1000 times more resistive than the mud.

It should be emphasized that the above conditions correspond to the usual cases of comparatively fresh muds and salty formation waters. The case of high salinity mud has not been treated.

3. The response of the induction logging devices were determined by computations. In these computations,

the "skin effect" was supposed to be negligible. This assumption is quite acceptable so long as the formation resistivity is not too low. For very low resistivity the skin effect has some importance, though not enough to affect appreciably the practical significance of the derivations.

The induction log readings were also corrected for the effect of the bore hole, when such effect was appreciable, i.e., for comparatively high formation factor values.

The responses of the conventional resistivity devices and of the laterolog, for the case of thick beds, considered as being infinitely thick, were taken from the catalogues of computed departure curves.[1] For thin beds, they were determined experimentally in the laboratory. The laboratory model used for this kind of investigation is a network of electrical resistors, which reproduce the actual distribution of resistivities of the media involved in the measurement.

Results. The results are presented in charts, where the values of the efficiencies R_a/R_t are plotted versus R_i/R_m. Each chart corresponds to a given value of R_t/R_i, D_i/d, and in case of thin beds, R_s. This presentation compares the efficiencies of the devices in terms of increasing formation factor or decreasing porosity, all other conditions being the same. For optimum efficiency R_a/R_t should equal unity (1 on the charts) for all values of R_i/R_m.

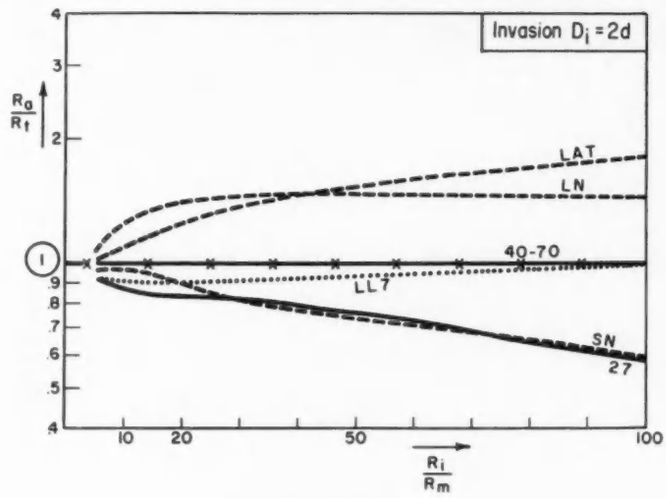
I. THICK BEDS

The results are given in Figures 2, 3, 4 for water bearing formations ($R_t/R_i = 1/10$) and in Figures 5, 6, 7 for oil-bearing formations ($R_t/R_i = 2$).

(a) The efficiency of all induction logging devices is excellent in case of shallow invasion, and it decreases with increasing invasion. All other conditions being the same, the efficiency, of course, improves with increasing spacing.

(b) Except for very low formation factors, the 40-inch and 70-inch spacing devices give values closer to R_t than the normals and the laterolog.

(c) For shallow invasion, the lateral device has a response little different from that of the induction log. For deep invasion, the comparative efficiencies of both types of devices depend on the values of saturation and of formation factor. If a



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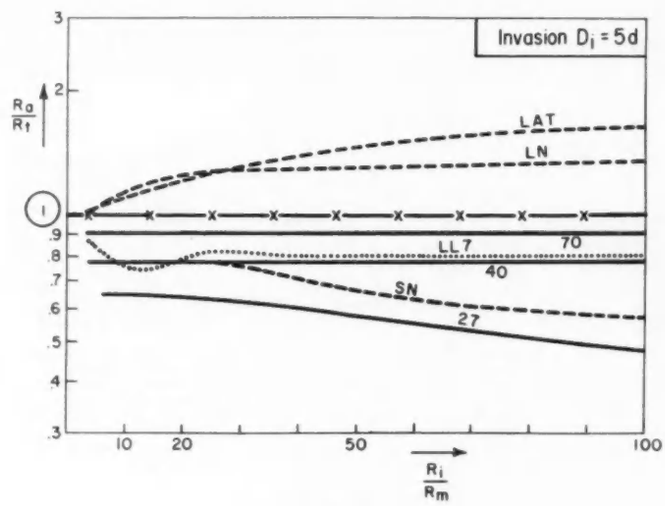


FIGURE 6

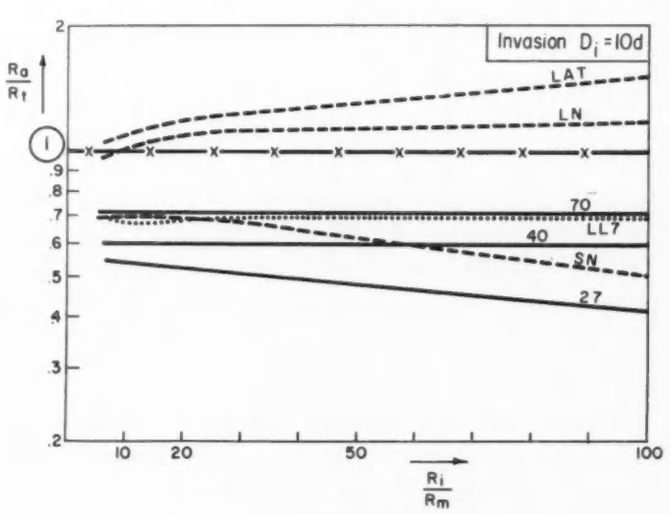


FIGURE 7

d = 8 inches; $R_t = 2R_i$. Note that except for very low formation factors the 40-inch and 70-inch spacing devices give five values closer to R_t than the normals and laterolog.

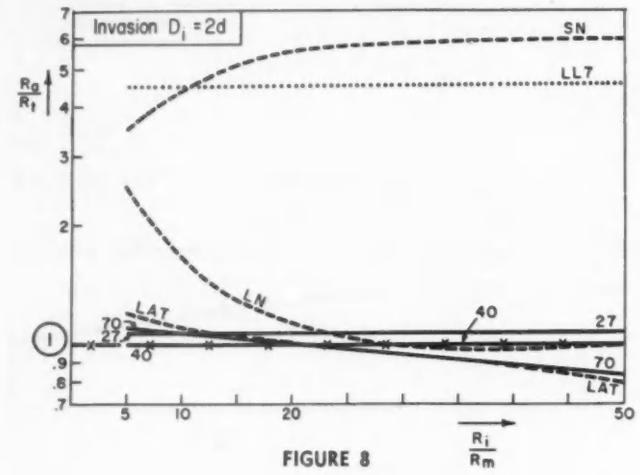


FIGURE 8

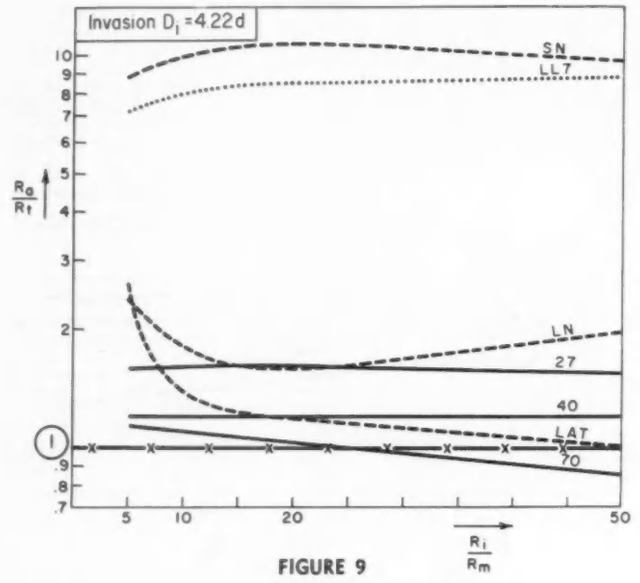


FIGURE 9

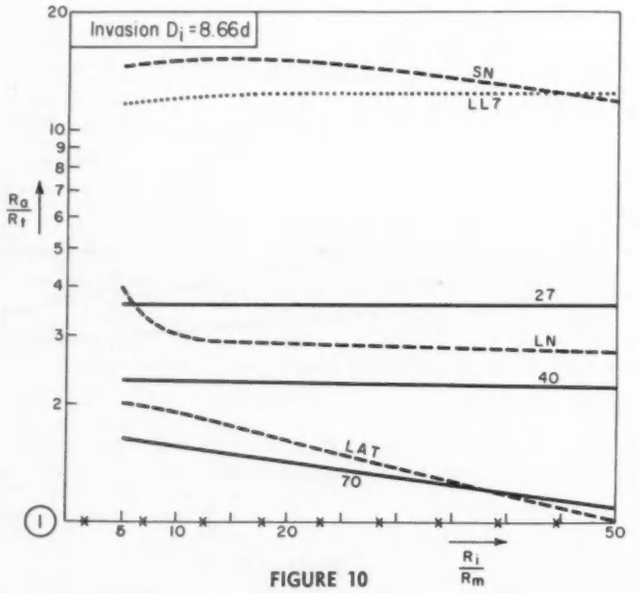


FIGURE 10

d = 8 inches; $R_s = R_m$; $R_t = \frac{1R_i}{20}$. Note that two distinct groups of curves are formed. Depending on the invasion the SN and LL7 read 5 to 12 times R_t, the efficiencies of the other devices are between 1 and 4 times R_t.

comparison is made with the 40-inch induction log, which is the spacing now being standardized for the combination induction-ES, it is seen that, in oil bearing formations, the values read with this tool are closer to R_t than those read with the lateral. For water bearing formations, the lateral is more efficient when R_i/R_m is less than about 50, and less efficient for higher values of R_i/R_m. Accordingly, the lateral will be more appropriate for the detection of water bearing beds than the 40-inch induction log (and still more so than the 27 inches), in formations with medium porosity (around 20 percent) which are deeply invaded (such as the Lower Wilcox in the Gulf Coast for example). This result, however, is given for beds of infinite thickness, i.e. in practice, for bed thicknesses several times as great as the lateral spacing. In fact, formations this thick are very rare. Moreover they are most often broken into thinner sections by hard streaks, which disturb the lateral curve appreciably, but which have practically no influence on the induction log.

(d) It seems that the 70-inch induction log would be the most appropriate device in case of deep invasion. Its advantage over the long lateral is that it is less affected by bed thickness, chiefly when R_t is less than R_s (as will be shown later).

II. THIN BEDS

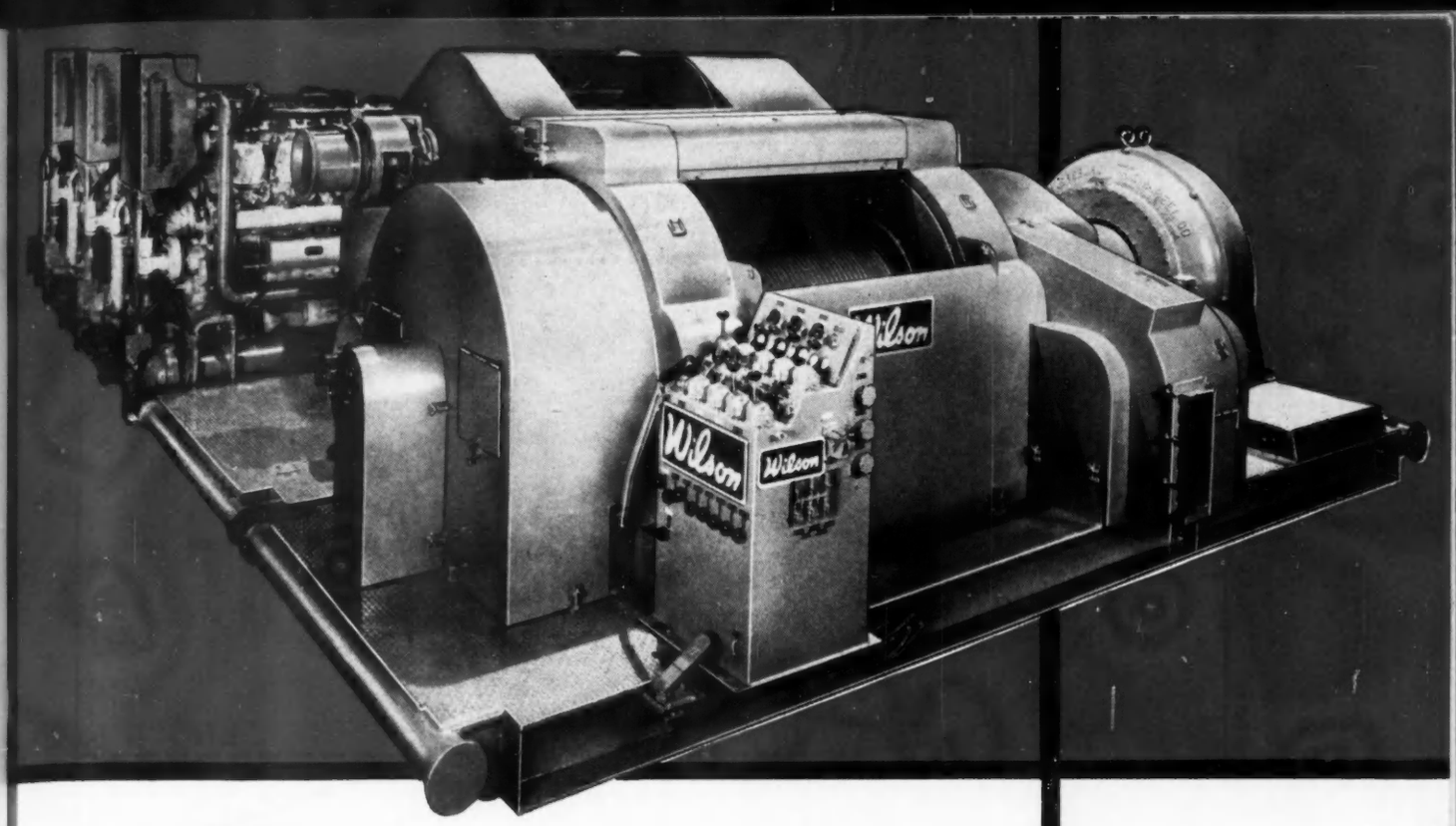
For a bed thickness e = 80 inches, as chosen for the present discussion, the effect of adjacent formations on the 27-inch and 40-inch induction log is not too important, chiefly when R_t is less than R_s. The efficiencies for these sondes therefore are about the same as in the case of thick beds.

With all the other devices, the effects of the adjacent formations and of invasion may sometimes compensate each other to some extent and the response of the device may improve. For other cases, however, the response may become worse.

The analysis of the results, for thin beds, is more complex than for thick beds, and it is more difficult to formulate a few simple conclusions having a general significance.

(a) Figures 8, 9, 10: Soft formations—water bearing R_i/R_m less than 50, $R_t = R_i/20$, $R_s = R_m$.

All of these charts exhibit two distinct groups of curves, one corres-



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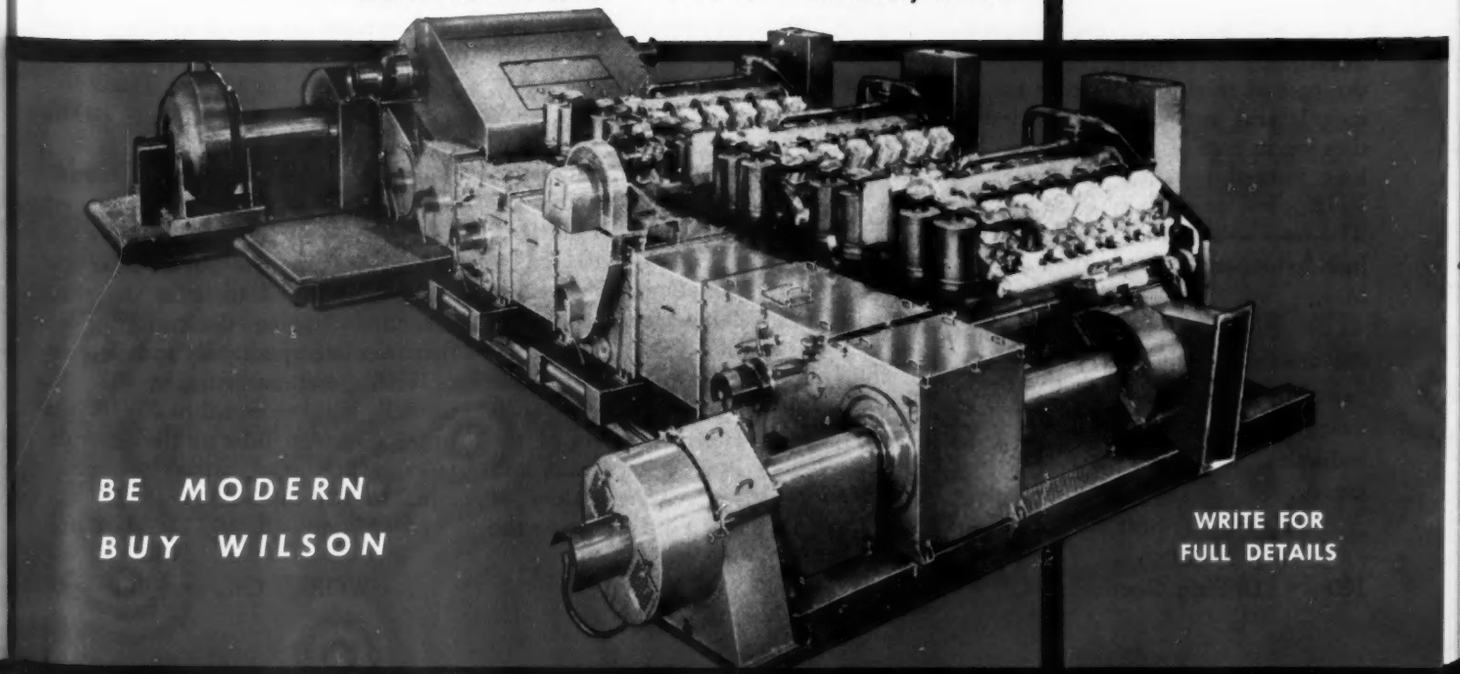

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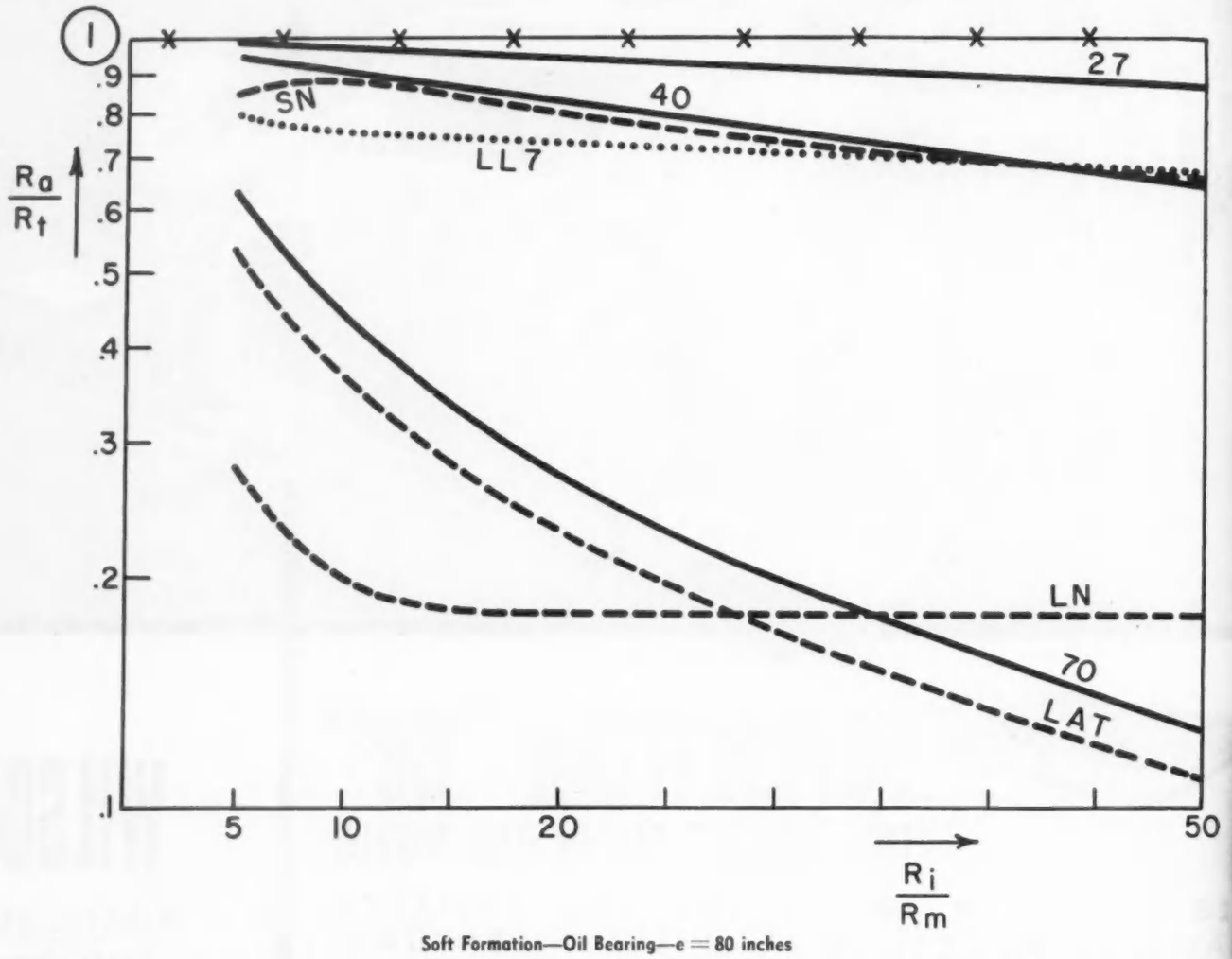

Soft Formation—Oil Bearing—e = 80 inches

FIGURE 11—Since $R_t = R_i$ depth of invasion is not considered. Essentially this chart shows the effect of the adjacent formations, since no invasion effect is superimposed.

ponding to SN and LL-7, the other one to the other devices.

Depending on invasion, the SN and LL-7 read between 5 and 12 times R_t, the efficiencies of the other devices being comprised between 1 and 4.

The efficiencies are not so greatly affected by the value of R_i/R_m, as in the case of thick beds, except for the long lateral and the 70-inch induction log in case of deep invasion. The long normal response is affected by R_i/R_m, but for medium invasion only. The responses of the 27-inch and 40-inch induction logs are practically uniform.

All in all, for shallow invasion all the devices of the lower group are practically equivalent. For deep invasion, the lateral and the 70-inch induction log have a better efficiency.

(b) Figure 11: Soft formation—oil bearing ($R_t = R_i$) all other conditions being the same as above.

Since $R_t = R_i$, there is no reason here to consider the depth of invasion and only one chart is given (Figure 11). This chart essentially shows the effect of the adjacent formations, since for this case there is no effect of invasion superimposed.

Two distinct groups of curves are again observed on this chart:

The upper group, including the 27-inch and 40-inch induction logs, the SN and the LL-7 is limited by ordinates .7 and 1. All four devices, therefore, are only slightly affected by the adjacent formations. Their efficiencies are all fairly good, with some advantages for the 27-inch.

The lower group includes the long normal, the lateral and the 70-inch induction log. Here the effect of the adjacent beds is very important and increases with increasing values of R_i/R_m or R_t/R_m. This is due to the fact that, since R_s is equal to R_m, increasing $\frac{R_i \text{ or } R_t}{R_m}$ amounts to increasing the contrast of R_t against R_s. The same trend would be observed, of course, if R_s and R_m were not exactly equal, but had close values.

(c) Figures 12, 13, 14: Hard formation—water bearing; $R_t = R_i/10$, $R_s = 100\ R_m$.

In this case R_s is greater than R_t or R_i.

The results are straightforward. The lower group of curves near and above ordinate 1 includes the three induction logging devices. The efficiencies are practically independent of R_i/R_m, and, accordingly, of R_t/R_m since R_t is taken equal to $R_i/10$. The upper group includes all the other devices, which read apparent values equal to 4-10 times R_t.

(d) Figures 15, 16, 17: Hard for-

CAT* D397s ..."FAST ON THE DRAW"

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Equipped with torque converters and compounded to power both draw works and mud pump, the D397s are giving outstanding performance. L. L. Bond, tool pusher, says the D397s have not only given excellent service but show a real advantage on the draw works because of their fast acceleration. "They respond much quicker than other diesels," he reports.

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MODERN HEAVY-DUTY OILFIELD ENGINES

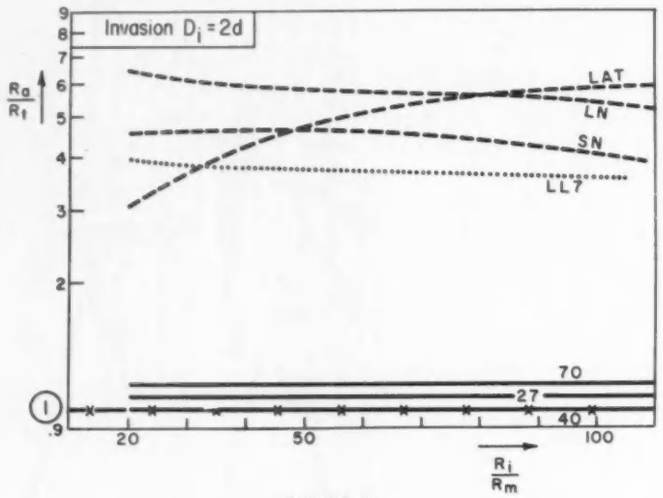


FIGURE 12

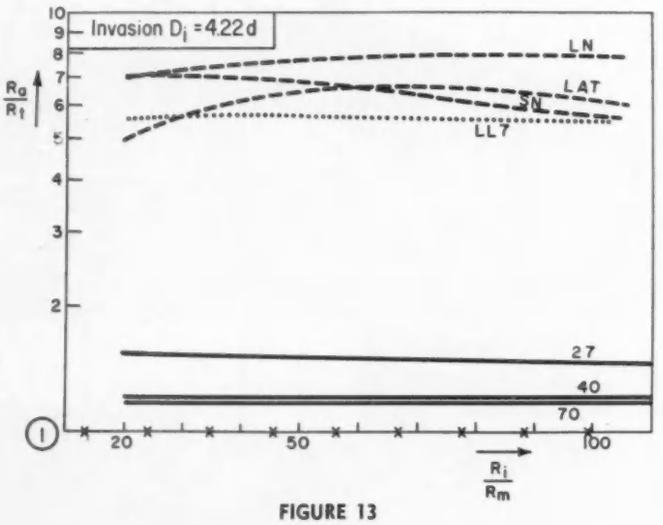


FIGURE 13

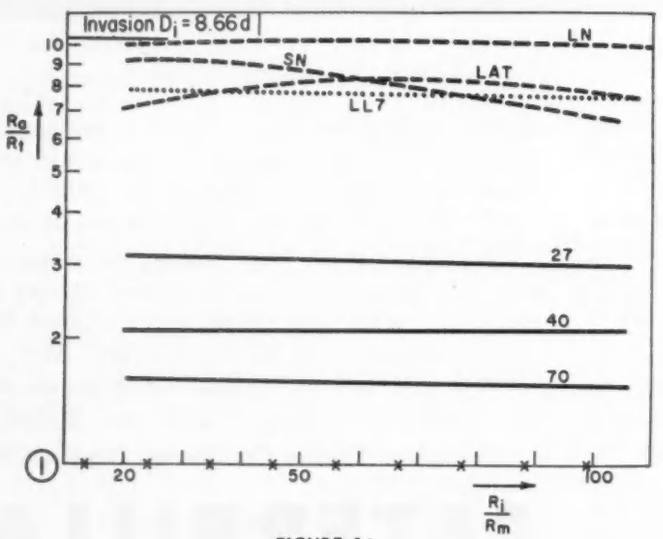


FIGURE 14

$d = 8$ inches; $R_s = 100R_m$; $R_t = \frac{R_i}{10}$

Note the two distinct groupings of the induction logs and the other devices. The efficiencies are practically independent of the formation factor.

mations—oil bearing; $R_t = 2R_i$, $R_s = 1000\ R_m$.

(This value of R_s was chosen in order to maintain R_t appreciably lower than R_s, which is the usual case in hard formations, whatever the value of R_i/R_m.)

On the charts, the upper group, including the lateral and the long normal, shows a uniformly poor efficiency. In the lower group, the 70-inch induction log gives the best average performance with the 40-inch induction log a close second. The laterolog and short normal have also a good efficiency.

Discussion. It appears from the above that a device which is more efficient than another one under a certain set of conditions may become less efficient when the conditions change. In order to assess the respective merits of various devices, it is therefore necessary to compare their average performances.

Such average comparative results are presented in a condensed form in Figures 18 and 19, for two typical cases.

Figure 18 was established for a bed, thickness e = 80-inches, with comparatively high porosity (R_i/R_m = 15, which corresponds to a porosity of about 20 to 25 percent), either water or oil bearing. For each device an over-all "co-efficient of merit" was determined by averaging its efficiencies for the usual depths of invasion in this type of formation. The coefficient of merit is taken as the average value of R_a/R_t, or R_t/R_a, whichever value is less than one.

The various devices are distributed on a horizontal line, in the order of increasing nominal spacings (this order, of course, does not necessarily correspond to increasing radii of investigation). The respective coefficients of merit are shown graphically on a vertical line at the level of each device. To facilitate the comparisons, the plotted points for the cases of oil and of water are joined together with a solid line and a dotted line respectively.

Similar representation is given on Figure 19, this time for a comparatively hard formation (R_i/R_m = 70 corresponding to a porosity of 10-15 percent), of the same thickness (e = 80-inches) bounded by more resistive adjacent beds.

The values of the coefficients of

merit were divided into five groups, denoted as A, B, C, D, E, with A corresponding to a merit rating between 1 and .8, B between .8 and .6 . . . etc.

Table 1 shows the distribution of the merit rates among the various spacings, according to the type of formation (soft or hard), and to the saturation (oil or water).

For soft formations, the classification of the devices, with decreasing merit rates will be as follows:

40, 27, 70, Lat, SN, LL-7, LN.

For hard formations:

70, 40, 27, LL-7, SN, LN, Lat,

and the average classification, for both types of formations:

40, 70, 27, SN, LL-7, LN, Lat.

Of course, such classifications are

About the Authors

Dumanoir

Martin

J. L. DUMANOIR holds a B.S. degree from the University of Lille, France, and is a 1942 graduate of Ecole Polytechnique of Paris. He has been with Schlumberger since 1946; first, as a field engineer in South America, then as district manager in Europe. In 1955 he joined the Schlumberger Well Surveying Corporation staff as Research Engineer in Ridgefield, Conn.

MAURICE MARTIN joined Schlumberger in 1929, and worked first as a field engineer, then as manager of operations in Europe. In 1948, he became affiliated with the Schlumberger Well Surveying Corporation, at its research center in Ridgefield, Conn., as head of the Publications Department. He holds a B.S. degree from the University of Paris and is also a 1926 graduate of Ecole Polytechnique of Paris.

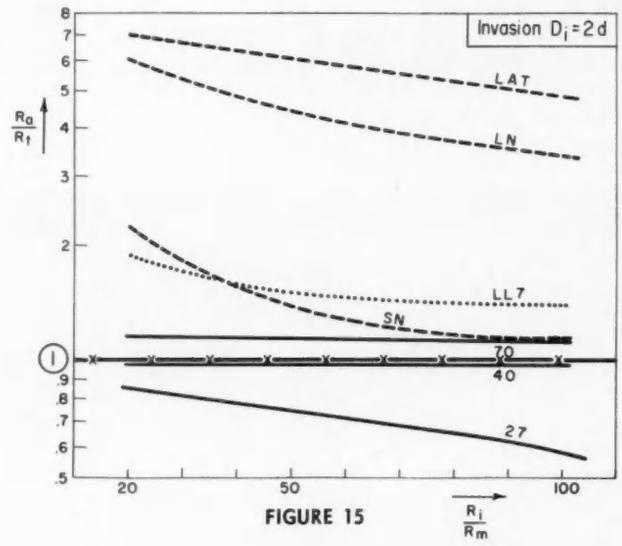


FIGURE 15

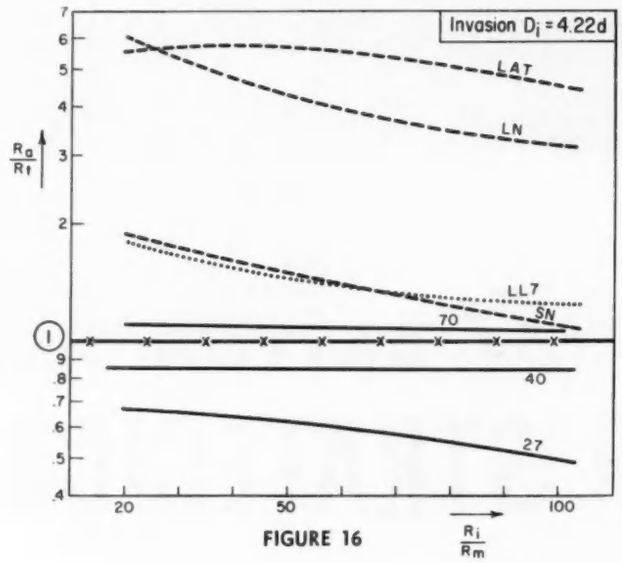


FIGURE 16

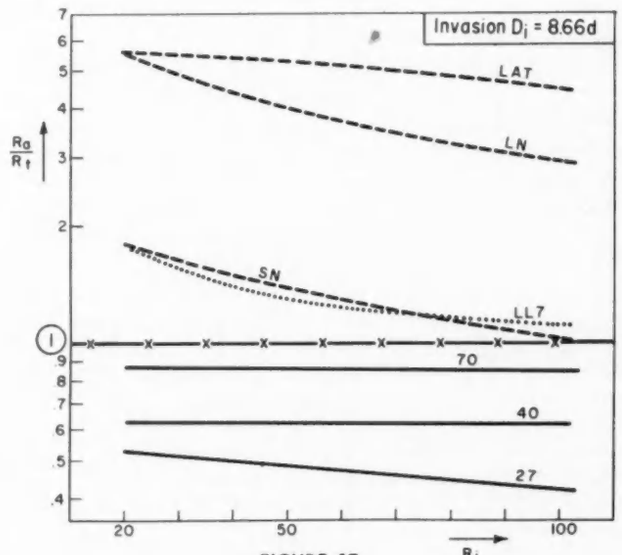
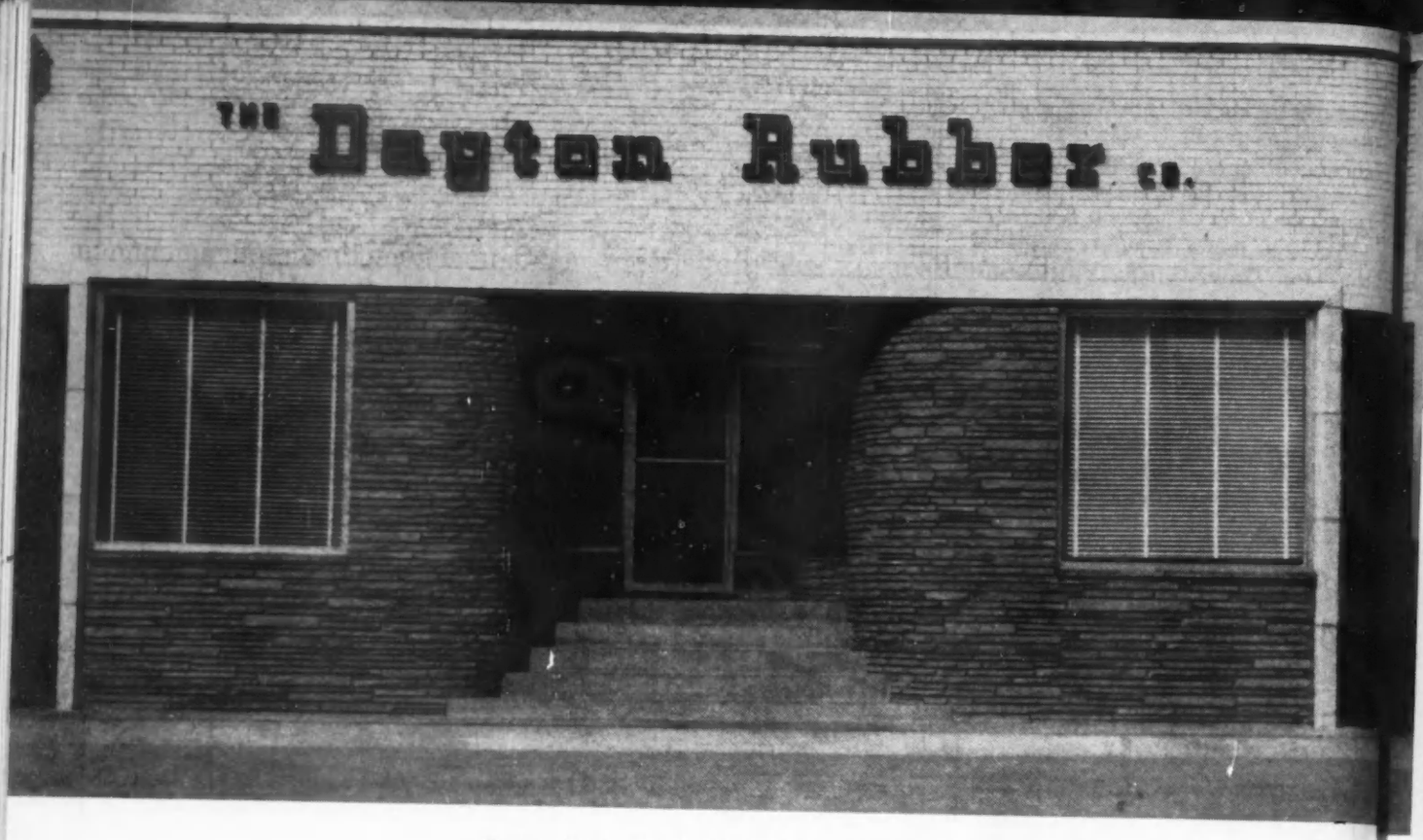


FIGURE 17

8 inches; $R_s = 1000R_m$; $R_t = 2R_i$

Under these conditions the lateral and the long normal show poor efficiency. The 70-inch gives the best average.



Dayton Regional Warehouses in Dallas, (above) Houston and Los Angeles carry complete stocks of V-Belts to assure ready availability from District Warehouses and Field Supply Stores. Before shipping matched sets each Dayton V-Belt is accurately checked on the exclusive Dayton Matchometer machine. (Right)

81 DAYTON DISTRIBUTION POINTS STRATEGICALLY LOCATED

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Los Angeles, Calif.—909 East Slauson
Dallas, Texas—925 Slocum
Houston, Texas—1308 La Branch

Dayton District Warehouses

California

Bakersfield—109 23rd St.
San Francisco—401 Howard St.

Texas

Corpus Christi—1920 N. Port Ave.
Odessa—111 N. Lee St.
Abilene—628-30 Walnut St.
Pampa—159 S. Cuyler St.
El Paso—1701 Texas St.
Wichita Falls—1300 Indiana Ave.

Louisiana

New Orleans—632 S. Peters St.
Shreveport—214 N. Market St.

Field Store Stocks

California

All Bethlehem Supply Stores
Bakersfield—Power Transmission and Equipment Co.
San Francisco—H. N. Cook Belting Co.

Texas

All Republic Supply Stores
Lubbock—Lubbock Electric Co. Bearing Specialists Co.
Midland—Electric Motor Service Co.
Cisco—Walton Electric Co.
Beaumont—Behring's Bearing Service Co.
San Antonio—Alamo Iron Works
Kilgore—Jack Anderson Engine Co.
Wichita Falls—Mims Bearing Co. Hornsby Heavy Hardware Co.
Pampa—Radcliff Supply Co.
Houston—Behring's Bearing Service Co.
Corpus Christi—Bradley's Motor & Armature Works
Odessa—Duke Electric Co.
Amarillo—Radcliff Supply Co.
El Paso—El Paso Saw & Belting Co.
Abilene—Carpenter V-Belt Co.

Oklahoma

All Republic Supply Stores

Louisiana

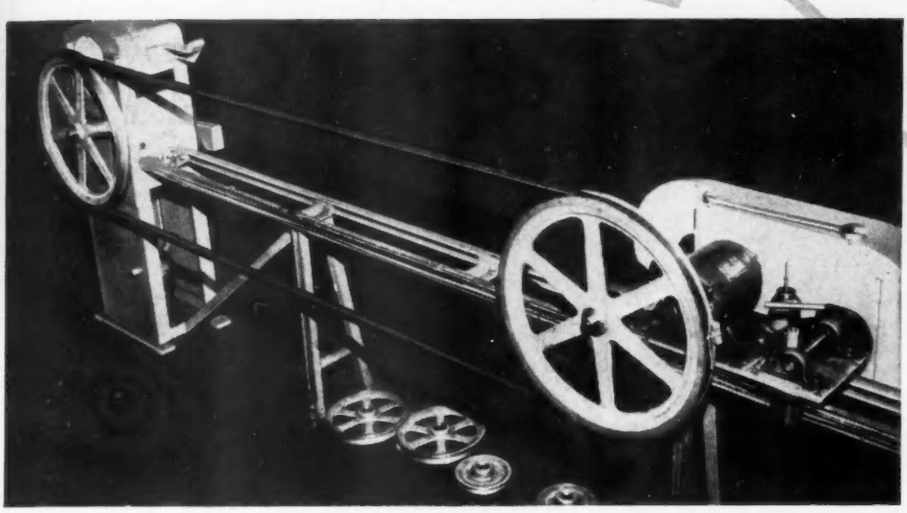
All Republic Supply Stores
Oil City—Oil City Hardware Co.
Lake Charles—Behring's Bearing Service Co.
New Orleans—New Orleans Belting and Bearing Co.
Shreveport—Bearing Transmission Co.

Kansas

All Republic Supply Stores
Coffeyville—Acme Foundry Co.

Wyoming

All Republic Supply Stores



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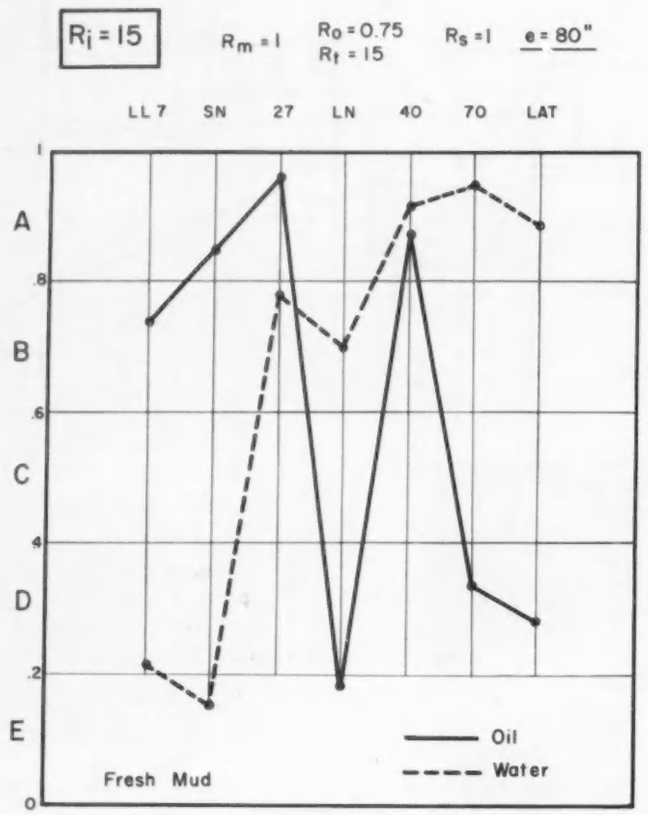


FIGURE 18

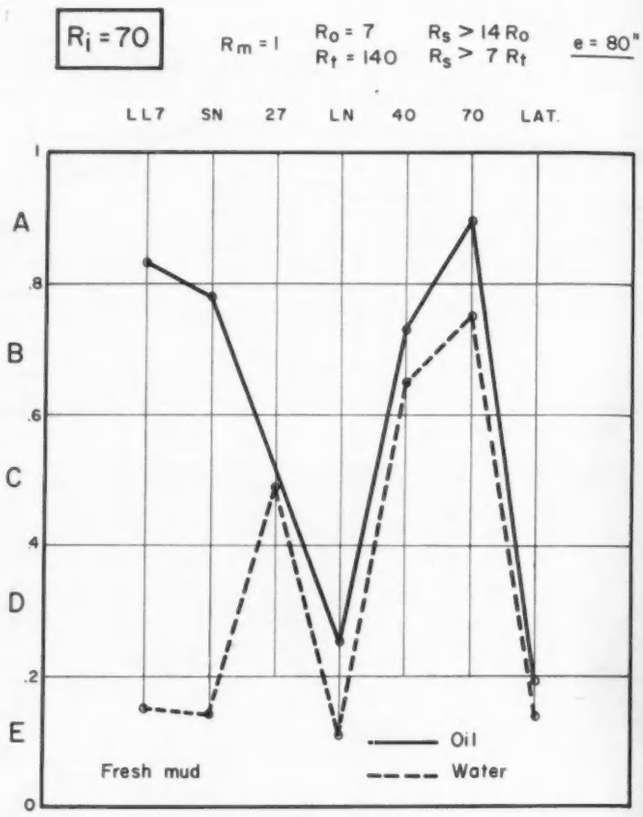


FIGURE 19

For each device a "coefficient of merit" was determined by averaging its efficiency for the usual depths of invasion in this type of formation. The coefficient of merit is taken as R_a/R_t or R_t/R_a whichever value is less than 1.

somewhat arbitrary. Deviations may occur, for conditions different from those for which the present comparisons were made. It seems, nevertheless, that the classifications shown above are fairly representative of the average trends in practice.

It should be said also that with the induction logging tools available at the present time, some limitation occurs in the accuracy of the measurements when the resistivity to be measured is high, for example, exceeds about 50 ohms. A correct measurement under such a condition can be made only if the zero of conductivity is exactly adjusted at the level of a bed which is known to be highly resistive by means of another resistivity log, preferably a laterolog.

Finally, as already stated, the discussion applies only to the case of fresh muds. For high salinity muds, the situation would be different, and the laterolog would take the first place.

Conclusions. The following conclusions can be derived from the preceding discussion, for the case of wells drilled with fresh mud:

The 40-inch induction log appears to be the most efficient device, since it gives a reading approximating R_t in the greatest number of cases.

However, in case of very deep invasion, an induction log with a greater spacing, for example 70-inch, may be preferable, especially when the adjacent formations are more resistive than the bed under survey.

The lateral shows a better efficiency than the 40-inch induction log, for deeply invaded water bearing formations of medium porosity (around 20 percent), provided the thickness of the bed is sufficient. This last condition, however, is very seldom met in practice, and a real improvement over the 40-inch should be sought through using an induction logging device with greater spacing.

TABLE 1

Merit Rating of Various Measuring Devices
(Fresh Mud)

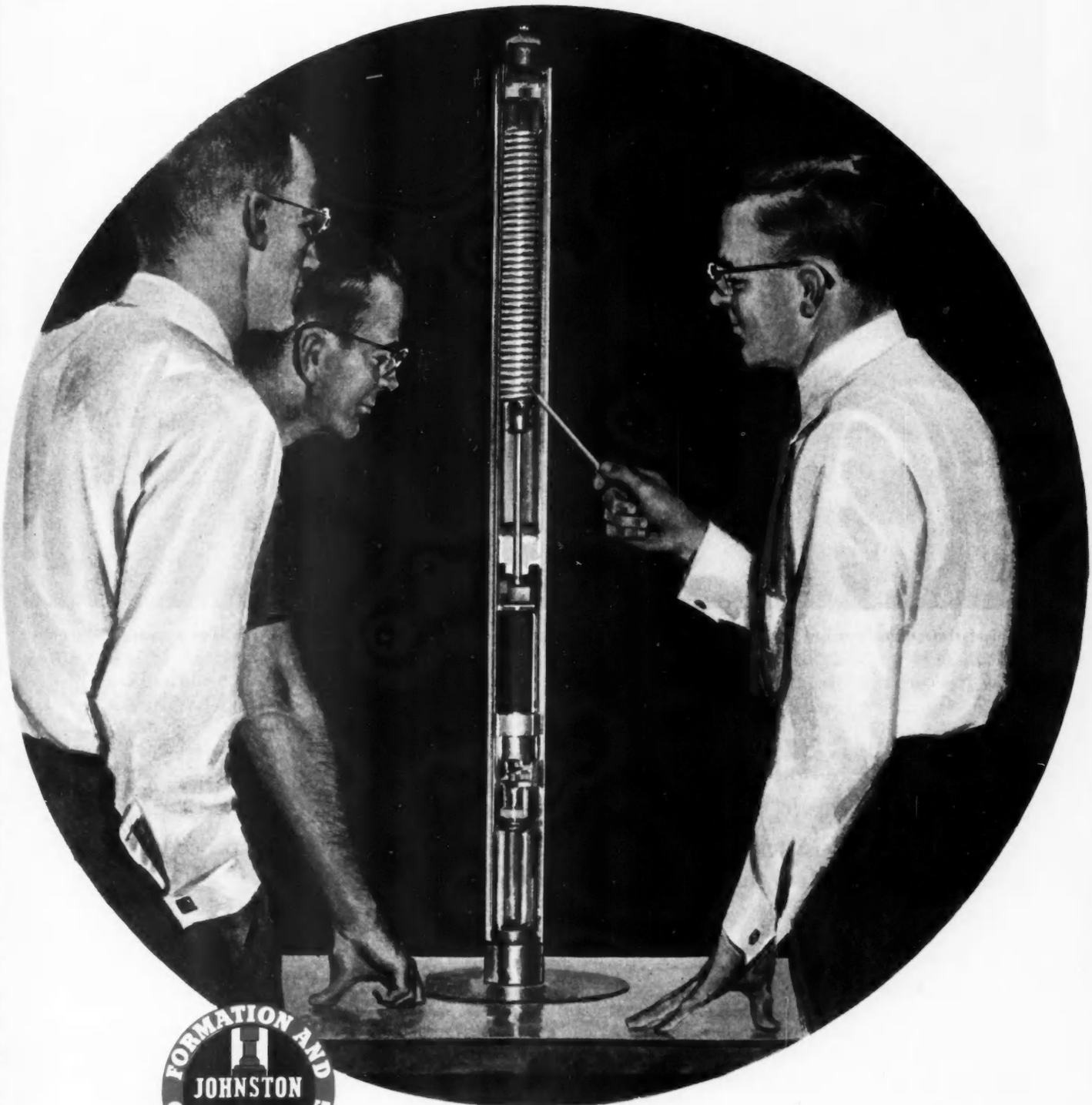
	Soft $R_t/R_m=15$		Hard $R_t/R_m=70$	
	Oil	Water	Oil	Water
LL7	B	D	A	E
SN	A	E	B	E
27	A	B	C	C
LN	E	B	D	E
40	A	A	B	B
70	D	A	A	B
LAT.	D	A	E	E

Although the induction log displays the best all round efficiency, it does not give an exact value of R_t in all cases: it is therefore still necessary to run the induction log together with an additional device to correct for the effect of invasion. In formations with comparatively low resistivities such as unconsolidated or moderately consolidated sands, the short normal gives a proper additional log for this purpose. In hard formations, the short normal log is generally appreciably distorted and is not a reliable auxiliary to the induction log. The laterolog should be used instead. Another advantage of running a laterolog is that it makes possible a correct adjustment of the zero conductivity on the induction log, which is necessary for accurate measurements of high resistivities.

At present, a combined tool is available which simultaneously records the 16-inch normal and 40-inch induction log in one run. The combination of induction log and laterolog is still under development.

REFERENCE

[1] Schlumberger Documents No. 7 and 6 respectively.



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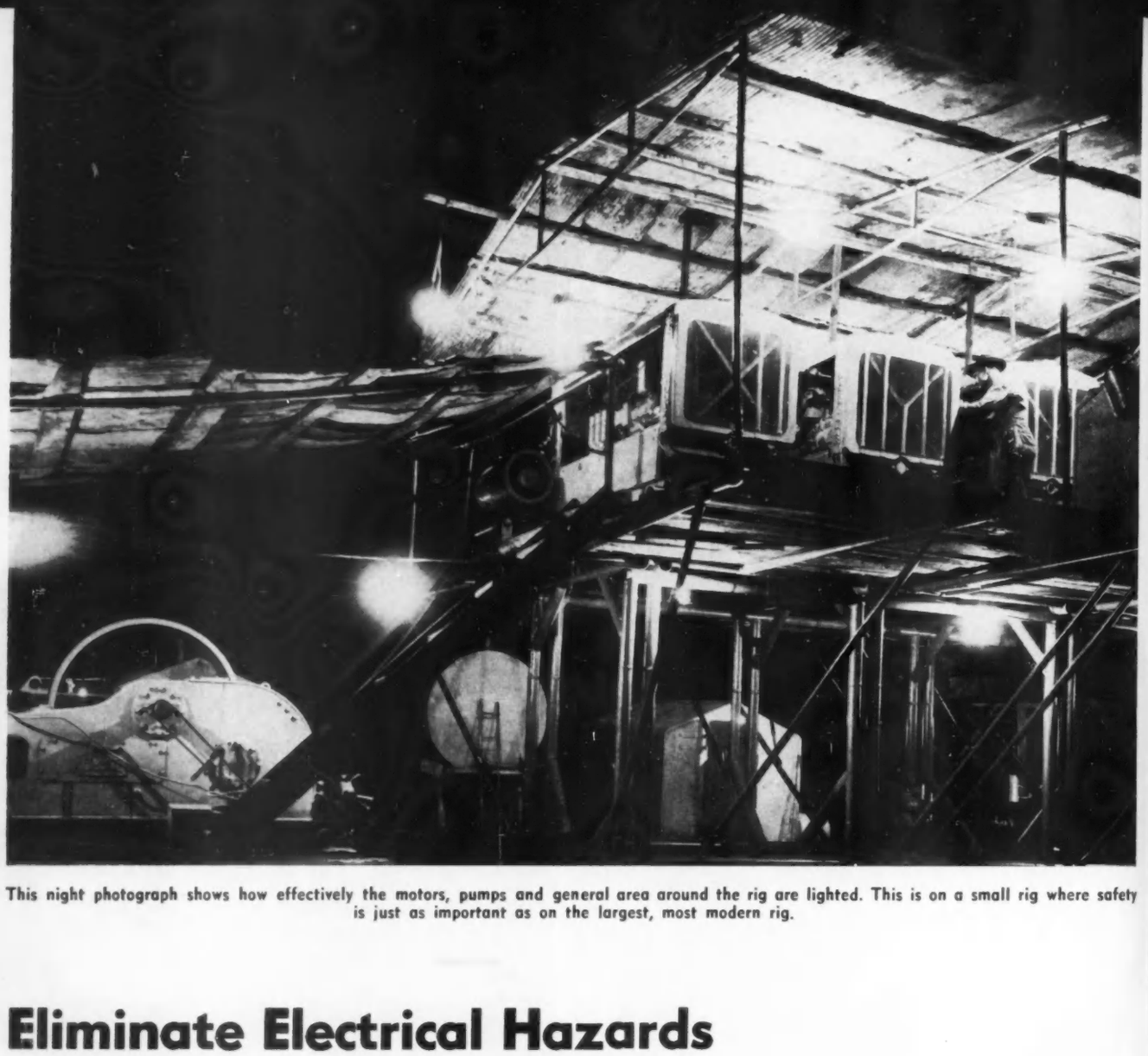


This night photograph shows how effectively the motors, pumps and general area around the rig are lighted. This is on a small rig where safety is just as important as on the largest, most modern rig.

Eliminate Electrical Hazards

Proper attention to basic installation and maintenance procedures on your rig will increase safety and decrease operating costs.

By W. R. SCRIMES,
Imperial Oil Limited, Calgary, Canada

USE OF ELECTRICITY around drilling rigs presents many hazards to personnel and property. These can be greatly minimized by:

- Using the best available approved equipment.
- Carefully planning electrical layout around the drilling operation.
- Enforcing a rigid maintenance program.

Approved, safe, electrical installations around a drilling rig will embody the following:

1. Lighting fixtures of the vapor-proof type consisting of a base capable of being sealed with compound and a lamp protected by an outer globe and metal guard. These will be found on the derrick and around the drawworks, mud pumps, pipe racks and substructure. All outside lighting on or around the tool house, generator house, change houses, etc., should be vapor-proof.

In fact all lighting, except that in various doghouses which are more than 25 feet from the well bore, should have vapor-proof fixtures. Here, although general purpose wiring, in rigid conduit with general purpose fixtures, may be used, good practice calls for installation of vapor-proof fixtures. All hand lamps should be vapor-proof construction, and no naked lamps or exposed wiring should be used.

2. Junction boxes, switch boxes and plug receptacles should be vapor-proof, capable of sealing, and with threaded couplings. All plugs should be of a locking type to prevent accidental disconnection.

3. Type S cable should be connected to the various junction boxes, etc., by approved screwed connectors

with rubber bushings or grommets installed.

4. All motors should be totally enclosed and have approved screwed cable connections.

In layout, installation, and rig moving, consideration should be given towards minimizing the hazard of mechanical damage.

The engine-generator should be located as close to the center of the lighting system as is practicable but at least 25 feet away from the well bore. This allows the main panel, if housed, to be of general purpose design, which would reduce cost considerably. Length of the feeders also is reduced.

Sufficient feeders should be run so that failure or shut-down of one section of operations does not affect another section. Lighting for the derrick, derrick floor and drawworks should be on a separate feeder circuit from the lighting for mud pumps, mud pit, etc. Separate feeders also should be run to handle change houses, tool houses, etc.

All feeders should be installed in the air and wherever possible clear of roadways. Portable tripod bases with pipe masts can be fabricated locally to raise the cables. All heavy feeders should be attached to a steel cable with telephone type clips, thongs or tape, and this cable should be anchored to the structure. This eliminates mechanical strain on conductors and minimizes breaks.

Lighting fixtures on the derrick should be connected to the legs and girts by flexible rather than rigid clamps wherever possible. Flexible clamps will cut down on breakage of lamps and lens because of reduced vibration. A suitable clamp can be made cheaply when the fixture is suspended from the clamp proper by short lengths of leather or web strapping.

Lighting circuit cables should allow plenty of slack to eliminate strain on cable connections at junction boxes, plug receptacles, fixtures, etc. The cable running up the derrick should be located as close to a leg as practicable for protection. It should be clipped to the derrick structure between fittings to reduce strain.

A typical, cheap connector can be made by tying a length of cord to the cable and connecting a battery clip on the other end of the cord. The cord is then looped around a girt and again clipped to the cable. In no case should the cable itself be used as a connection to the structure. This causes broken cable.

Lights around the rig, such as for cellar and pipe rack, can be connected to the substructure. It is preferable to have these floodlights mounted on tripods so they can be located where they give the most light and still not be in the way of operations. The same holds true for lighting around mud pits, water storage tanks and other ground locations that require floodlighting. If possible, cables should be kept off the ground to reduce the hazard of shorting and possibility of injury to personnel.

It is important that the distribution switch panel be located near the driller so that he immediately can turn off any circuit near or on the rig in case of emergency. This enables him to minimize the fire hazard and permits isolating circuits around trouble spots without a complete shutdown.

When wiring-up a location, provision should be made for ample floodlights mounted on tripods to minimize all possible hazards to personnel and equipment.

A rigidly controlled and enforced maintenance program ranks in importance with safe electrical installation and good electrical equipment around the drilling rig.

The first essential requirement of any sound electrical maintenance program is that only qualified electricians be responsible for maintenance. A contractor with several rigs will find it economical to keep a qualified electrician on his payroll. The one-rig contractor can train his crew in the safe, reliable methods of installation, and contract his maintenance to a qualified electrical firm.

Maintenance programs vary to suit particular circumstances. However, the following general rules should be considered in setting up a program:

1. Designate responsibility and authority for carrying out the program.

2. Thoroughly inspect all new rig lighting equipment before installation. Inspect for poorly fitted packings on floodlights, doors, boxes, cord entrances, hand lamps and globe fixtures. Do not install any equipment not considered in first class condition.

3. Schedule a regular inspection of all equipment. The periods between inspections are determined by experience with the equipment. In no case should the period exceed six months.

4. Maintain a supply of spare parts to keep equipment in first class condition. Complete spare assemblies should be made up and be available so that if some portion of the assembly is defective, the whole assembly can be replaced quickly and the defective one repaired and returned to spare stock. Standardization will help reduce spare parts requirements.

5. Maintain intensity of illumination at a safe level at all times. Clean glassware frequently. When floodlight lenses can no longer be cleaned to nearly perfect transparency, they should be replaced. The same applies to vapor-proof globes.

6. Never remove guards on vapor-proof lighting units except to clean them. Then replace them immediately. If globe breakage in these fixtures is unduly high, the fixture should be protected with a reflector or the globes replaced with a thicker glass.

7. Locate fixtures carefully and make re-lamping as convenient as possible.

8. Maintain hand lamps in first class condition at all times. Replacement parts should be on location.

9. Maintain belted hangers, clamps, and mounting brackets in first class condition. Rusted iron parts and aged belting should be discarded.

10. Provide a method to test for grounds and make frequent checks.

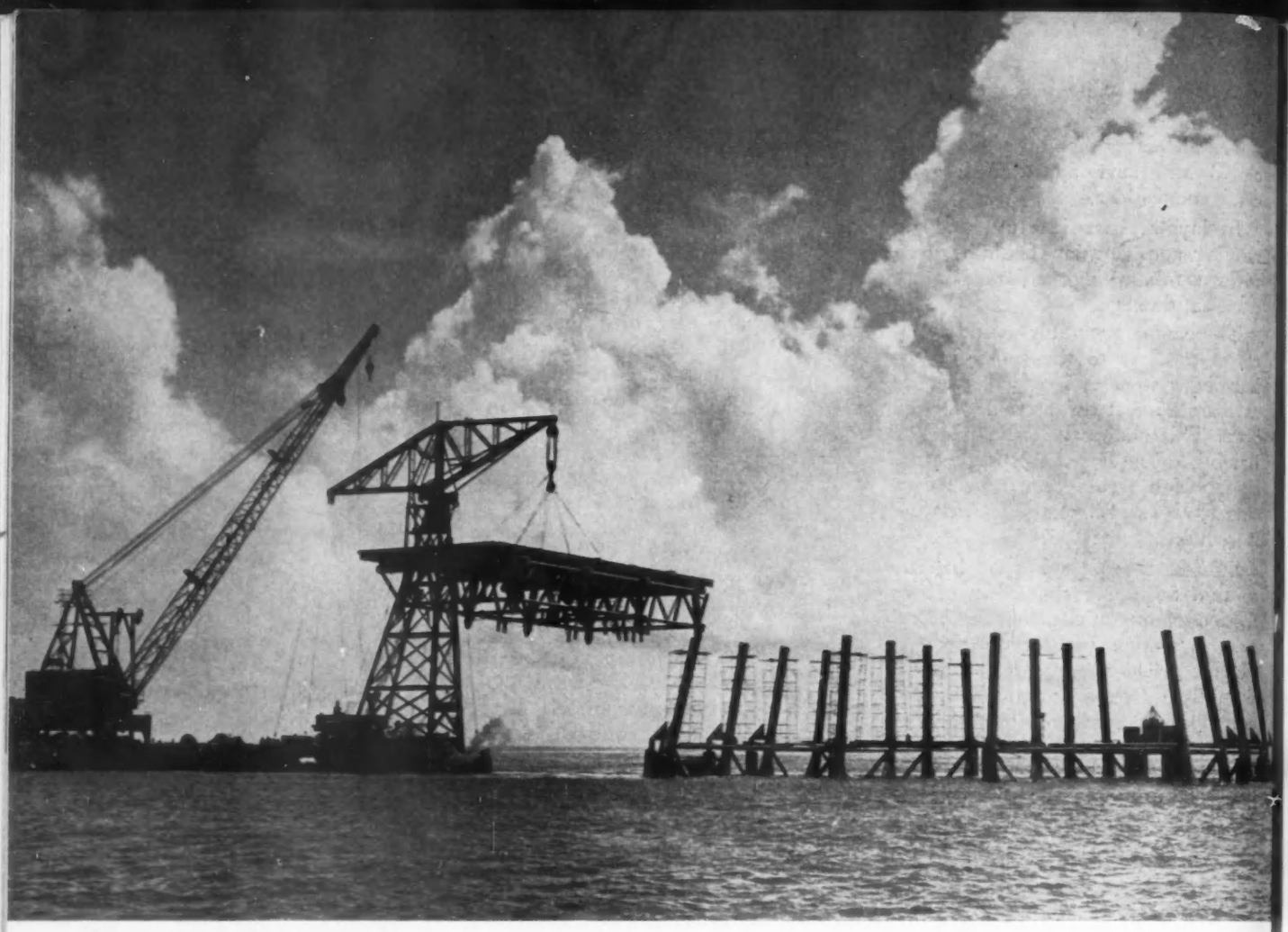
11. Replace cords that become worn, cut, or broken instead of taping them. If necessary, a shield should be provided for a cord subject to unusual wear.

12. Keep generator manufacturer's instruction book available at all times. When A-C switchboards are used, the operator should have a diagram of connections and an instruction book on the voltage regulator. However, when work on the engine governor or voltage regulator is necessary, a service man familiar with these devices should be called.

If the above maintenance suggestions are followed, reliability of equipment will be improved and hazards reduced immeasurably.

ACKNOWLEDGMENT

This article is based on a paper presented at the Fourth Annual Oilwell Drilling Safety Clinic at Banff, Canada, and sponsored by the Canadian Association of Oilwell Drilling Contractors.



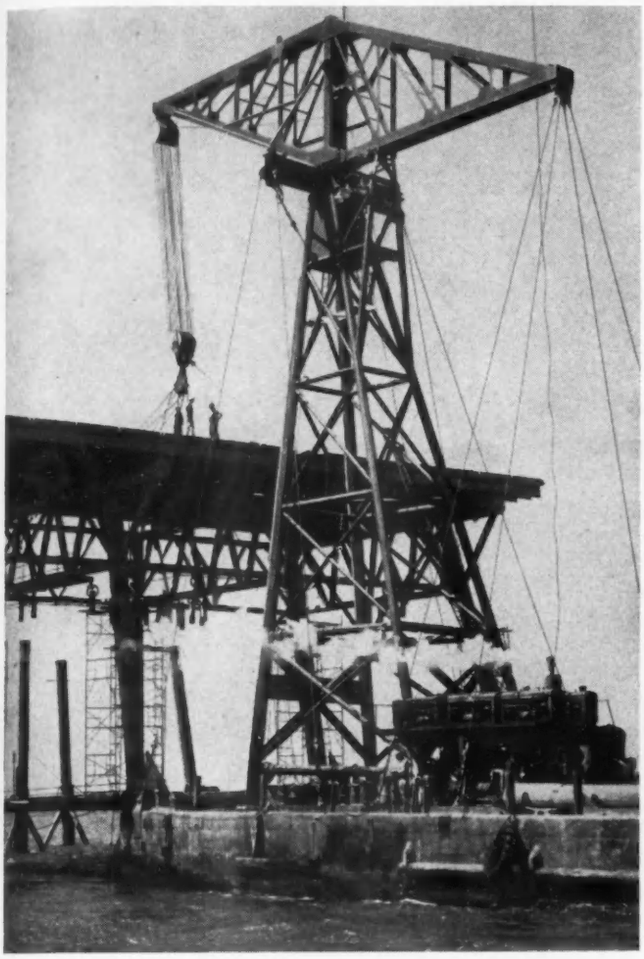
1 One of the 250-ton deck sections swings high in the air from a derrick barge as the barge inches backwards on anchors to set it on top of waiting piling. Note the spread angle at which the piling has been driven deep into the ocean floor for greater stability.

New Platform Has Slanted Piling For Deepest Gulf Drilling

Operating in 112 feet of water, the piling on CATC Group's platform is slanted out one foot for each foot of vertical depth. The result: greater stability.

THE CATC GROUP has begun its search for oil in the deepest water yet attempted by the oil industry anywhere in the world. The test, in 112 feet of water, is 22 miles off Grand Island, Louisiana, in Block 43. The huge platform weighing 1400 tons, not counting the derrick and machinery, was prefabricated in Houston. The construction company then towed the rig on barges to the site and erected it in the record depth.

The deck of the big platform is 55 feet above water level. Steel pilings 260 feet long are hammered 106 feet



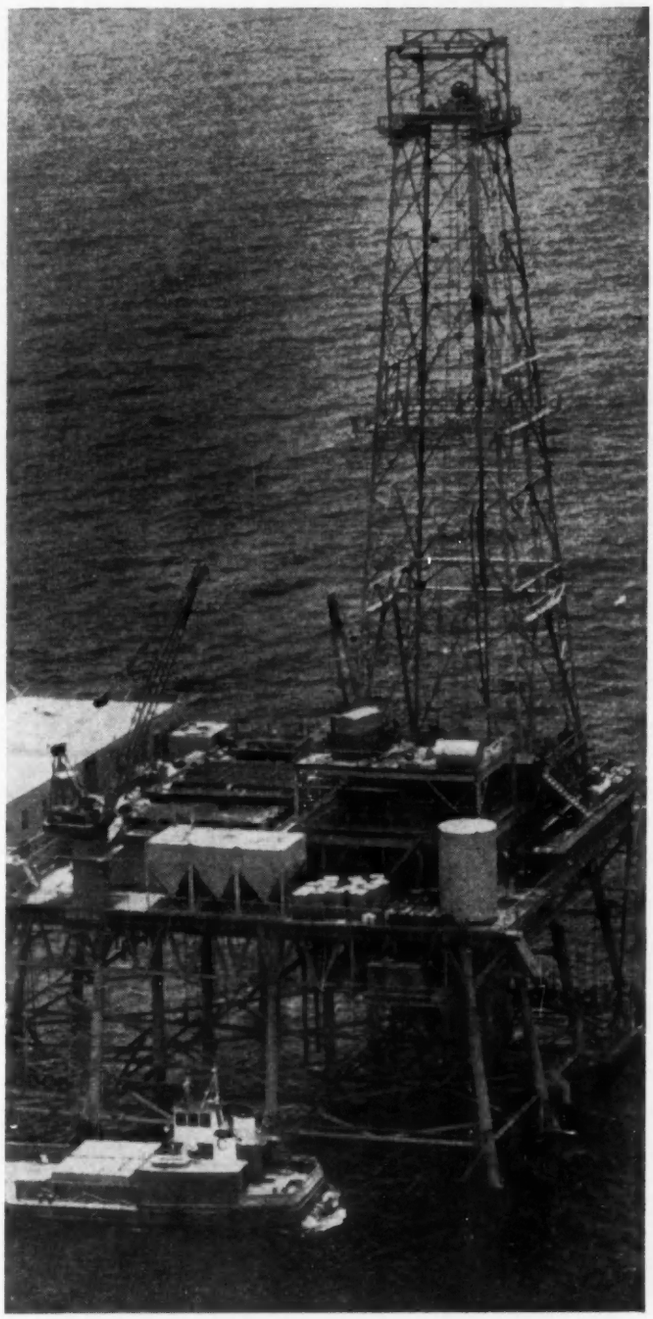
2 Big deck section is now securely set as the derrick slacks off its lines. Scaffolding is still in place and will be used by welders to weld legs of deck to piling.

into the bottom of the Gulf, giving a stable and sturdy platform capable of withstanding 125 miles per hour hurricanes.

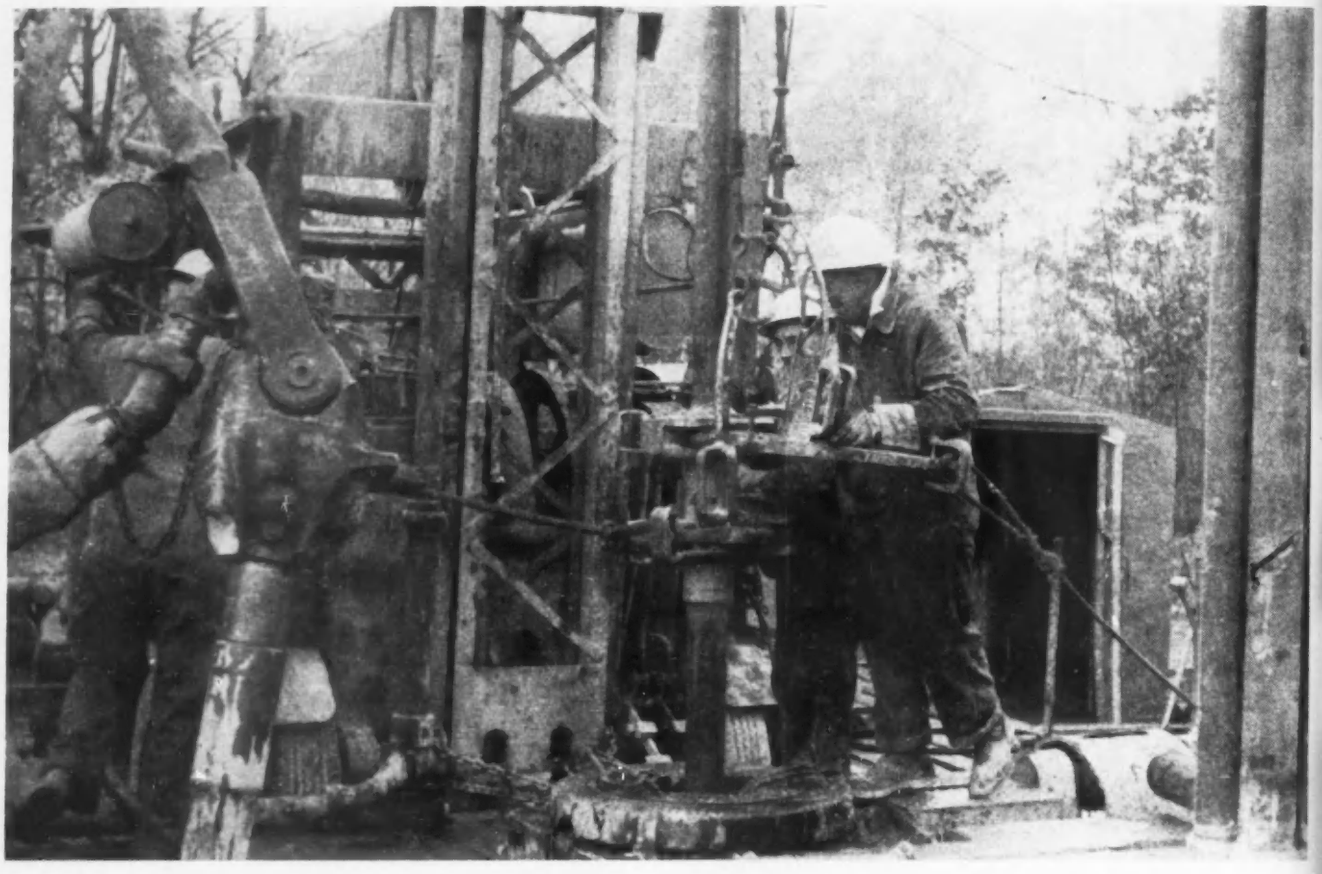
The CATC platform utilizes a new "slanted" design for increased stability, with the piling angled outward one foot for each six feet of vertical depth. The platform is 110 feet wide and 146 feet long and contains air conditioned quarters for a crew of 36 men, storage facilities and helicopter landing deck. Two 30-ton cranes stand at either end of the platform to load equipment. The derrick is designed for drilling six wells by moving the crown block into six different positions. The derrick base can then be skidded 22½ feet and six more wells can be drilled.

The standard power rig has four 600 horsepower engines and a drawworks that is capable of drilling below 16,000 feet. There are two 700-hp mud pumps with an independently driven 250-hp pump for mud mixing. The platform has storage space for 4200 sacks of bulk mud and 1400 sacks of bulk cement. Storage is also provided for mud chemicals and water.

As evidence of the tremendous cost of the offshore gamble, the rig, erected, cost approximately $1.2 million. The CATC Group, largest leaseholder in the Gulf of Mexico, was organized in 1946. Today they have 43 oil and gas wells in 14 fields off Louisiana and hold more than 400,000 acres off Louisiana and Texas.—**The End.**



3 The platform has been assembled, the derrick erected and operations are proceeding in 112 feet of water 22 miles off Grand Island, Louisiana.



This view from the front of the spudder shows the rotary table drill pipe, swivel, and base of the spudder mast.

Combining Rotary and Cable Tool Drilling

Rotary tools are used to drill through unconsolidated glacial drift, water zones, and for setting pipe. Cable tools take over for lost circulation zones and for completion work.

By VANCE W. ORR
McClure Oil Company, Alma, Mich.

DRILLING PROBLEMS in the Michigan Basin are complicated by an unconsolidated glacial drift section from the surface down to as much as 1000 feet. This section has caused contractors to develop a successful technique using combination rotary and cable tools. The average thickness of the "Drift," as this unconsolidated formation is called, is from 400 to 500 feet throughout the state. It presents a problem when cable tools alone are used because the pipe must be driven through this section. The use of rotary tools makes drilling comparatively simple; drilling time is short and only a minimum of casing is required.

Another drilling problem common to Michigan operators which makes the rotary and cable tool combination practical, is that below the Drift there is a caving section which causes considerable trouble in cable tool holes but which poses no difficulty for the rotary. There are also many water impregnated sections throughout the hole which are difficult to bail dry. Naturally a wet hole drills much slower and is more expensive when cable tools are being used. But with rotary tools, such sections can be handled with comparative ease.

All of these problems encountered in cable tool drilling increased drilling costs and were time-consuming. It became imperative that some method be devised whereby rotary tools could be used economically through the upper sections of the hole where the problems presented by the Drift and wet sections were encountered, while still retaining the advantages of the cable tools.

The first use of a combined rotary and cable tool unit was tried in the Michigan area several years ago. This method was used primarily to penetrate the Drift section. Most of the

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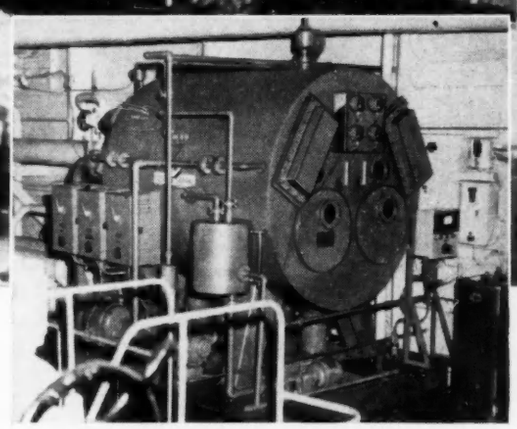

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Waste Heat Evaporators vs. Vapor Compression vs. Multiple Effect vs. Purchased Water

ITEM	UNIT PRICE	Typical Cost/1000 gal H_2O Waste Heat	Vapor Compression	Multi-Effect	Purchased
Diesel Fuel	@ 10.6¢/gal	$0.00	48¢	$4.80	
Electricity for pumps	@ 1¢/kw	20¢	1¢	14¢	
Lubricating Oil	@ 77¢/gal	½¢	6¢	½¢	
Acid for Descaling	@ 50¢/gal	½¢	20¢	½¢	
Maintenance and Repairs	Based on Field Experience	2¢	18¢	2¢	
Operational Labor	@ $2.50 hr	10¢	85¢	75¢	
Operational Costs (1000 gal)		33¢	$1.78	$5.72	
Operational Costs (barrel)		1½¢	7½¢	24¢	25¢
Operational Daily Costs (685 barrels)		$10.28	$51.38	$164.40	$171.25

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pioneering work in this type of drilling has been done by McClure Oil Company and this information is based on operating data from that company.

When drilling contractors were first confronted with the difficulties of penetrating the upper Drift section the practice was to move in rotary tools and drill through the section which might extend anywhere from 500 to 2000 feet. Then cable tools were moved over the hole. This, of course, involved two complete moves for each hole and resulted in excessive drilling costs. It was felt that in a cable tool country some better drilling method could be devised which would reduce or even eliminate this unnecessary moving expense. Rotary tools could be used to great advantage if the high cost of moving in and out could be cut down.

Essentially the contractor starts off with a cable tool rig. McClure Oil Company has used spudders, and also portable equipment under standard rigs. Rotary equipment is more suitable to put under spudders than under other types of cable tool drilling equipment.

Spudders must have a minimum mast head of 52 feet and be equipped with catheads in order to break-out tool joints on the rotary pipe. The spudder is used strictly as a drawworks unit, using the calf wheel and casing lines for the working drum. A rotary mud pump is necessary and is set permanently on a loboy trailer. This facilitates fast moving. A rotary table with power take-off must be provided. As a table opening of at least 17 inches is required, an 18-inch opening, lightweight rotary table is used. Power is direct and the entire unit is set on skids and moved as a single unit. The rotary equipment is similar to a normal rotary rig: a traveling block assembly which must necessarily be short under a spudder, a swivel, a short kelly, hose connections, drill pipe, etc. No. 1 drill pipe is used which averages about 22 feet, and is 4½-inch full-hole pipe. This rotary equipment, depending upon the size of table, pump, etc., costs between $40,000 and $65,000. The particular unit used by McClure Oil Company is equipped with a sizable mud pump and represents an investment of approximately $60,000. The spudder is a separate cost item.

The rotary tools under a cable tool machine are first used to set casing through the drift. In Michigan this is generally a 10¾-inch string. (In areas where there are no water sands above the first producing formations, 7-inch casing is run when the Drift section is drilled.) The 10¾-inch drive pipe, when specified, is used because of a drilling problem at the base of the Drift.

Rotary tools are still used to penetrate the water-bearing sands down to the base of the Marshall formation which is found at depths varying from 700 to 2100 feet. At that point 7-inch casing is set and water seeps are not anticipated for the next 1400 to 1500 feet. At the present time, the rotary is being used to set pipe through the Silurian and Niagaran sections for many Trenton tests are made in the southern part of the state at depths up to 3100 feet.

There are portions of a hole where the operator requires cores. With rotary tools it is possible to go in with a core bit and take a core of any specified zone. Rotary tools may be used inside 5-inch casing and also where a considerable interval must be drilled it would not be practical to use cable tools. By using 2⅞-inch tubing, equipped with tool joints, it is possible to work inside 5-inch casing for testing, coring or drilling operations.

During rotary operations, the cable tools also play an important part. In many cases, circulation is lost at the base of the Drift from 300 to 700 feet below the surface. When this happens the rotary tools are at a standstill until circulation can be restored. Cementing or using lost-circulation materials may help regain circulation but it has been found that it is usually much cheaper to set aside the rotary tools and begin driving casing which is already in the hole. The operation can be switched from rotary tools to cable tools in four hours, and in 48 hours as much as 100 feet of drive pipe can be driven and the lost-circulation zone completely sealed off. With one or two hours of work, rotary tools are back over the hole and drilling is resumed.

Some operators specify a cable tool test of many of the formations. Occasionally these formations are encountered in the section drilled with rotary tools. If the operator wishes, a string of pipe may be run; the hole bailed dry, formation to be tested is drilled with cable tools, the well is tested, the casing pulled and rotary drilling is resumed. Tests have been made successfully in both gas sands and oil pay zones in this manner. From the time the rotary tools stop until they are running again, having set a string of casing, dried up the hole and drilled the possible pay zone with cable tools, is a lapse of 30 hours.

The prime use of the cable tools in this combination unit is the completion of a hole once the upper portion, or rotary portion, has been drilled, to where it is more advantageous to change to cable tools. In most instances, in the Michigan Basin, this has been the bottom 2000 feet of hole. Some of the many advantages of using combination tools are:

- Combating lost circulation while using rotary tools.
- Setting surface pipe with rotary tools through thick unconsolidated formations saves the long and hazardous job of driving pipe.
- The interchange of rotary and cable tools in the hole so as to take advantage of the proper tools represent a savings in drilling costs.
- Elimination of an intermediate string of casing, the cave string.
- Pipe set with rotary tools is generally more easily recovered in the event of a dry hole. This is because the drilling mud acts as a sealing agent behind each string of pipe.

Pipe recoveries in most instances have been very high. It is not necessary to use cement in setting any of these strings of casing unless it is required to protect oil and gas or fresh water zones.

There are other possible applications of rotary equipment under spudders.

Often in the thick Drift area a drive pipe might be frozen, in a caving hole where headway cannot be made with cable tools, or cable tool drilling in a deep hole is so slow that it is uneconomical, then rotary tools may be used to good advantage. Rotary tools have been used successfully to cut cores under a spudder to a depth of 5275 feet.

The combination rotary and cable tool unit has been found practical and economical in Michigan. There are no serious mechanical problems involved in the unitization. It is believed that in areas where problems such as have been described here, prevail, these techniques can be applied successfully. —**The End**

Wire Rope at Work—This was moving day for the Sharp Drilling Company, Midland, Texas. The rig had drilled beyond 10,000 ft on the D. W. Wright Lease, Northwest Sherman Field, and now the time had come to pull up stakes. The photograph shows three of the crew as they began preparations for the move.

The rig components were due for a breathing spell, though it would be a short one. The Bethlehem rotary line, for example, was already earmarked for the next drilling job. A 6x19 Seale in the Purple Strand grade, it was good for many more ton-miles of service. This Bethlehem rope had weathered some pretty mean drilling, yet it was still full of life, still very fit, and entirely ready for the tough work ahead.

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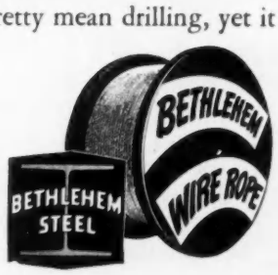


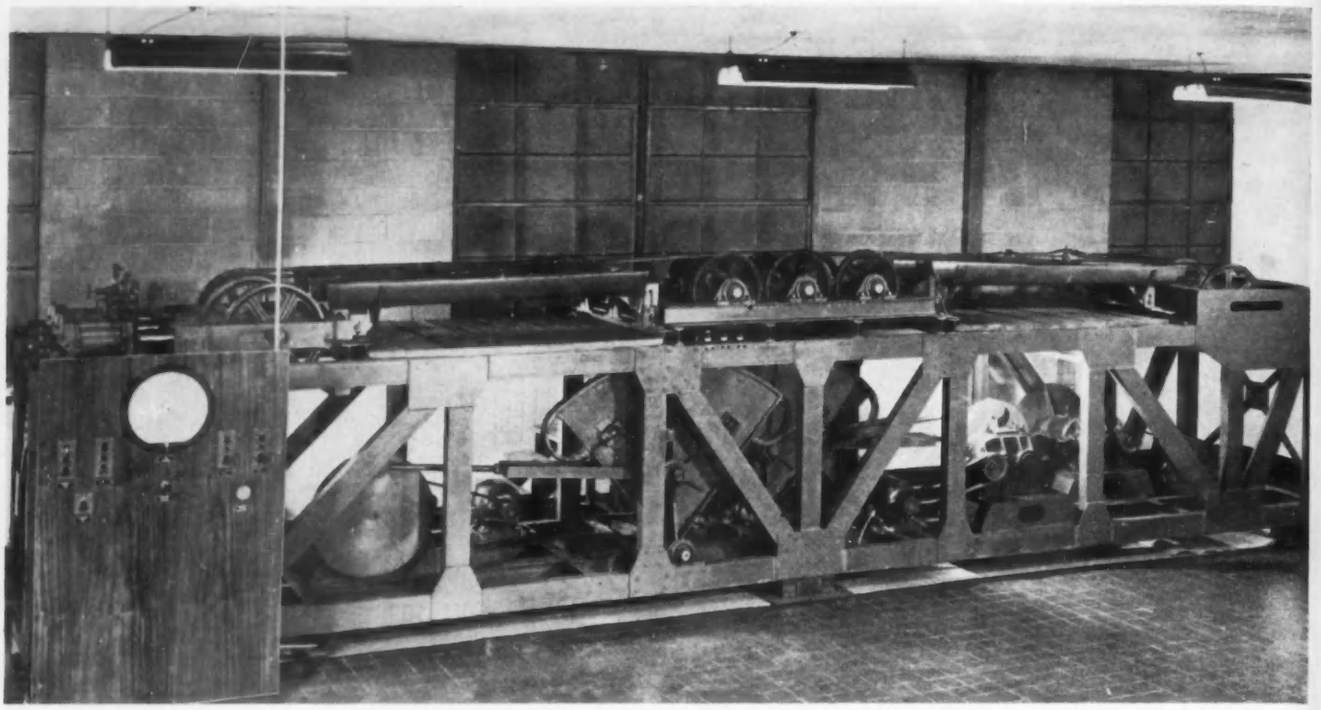


FIGURE 1—Bending tests were made on this fatigue machine.

How bending stresses affect the selection of . . .

Sheaves and Drums for Wire Ropes

By C. M. ZERR, Chief Engineer,
Union Wire Rope Corporation, Kansas City, Mo.

PROPER DESIGN and use of sheaves, drums, and other equipment used with wire rope is of the greatest importance in obtaining maximum service and safety. Because of the many different types of equipment and conditions under which wire rope operates, it is impossible to say that any particular size of sheave or drum is the most economical to use.

Determination of the most economical design of a mechanism to best meet the limiting features imposed by operating characteristics of wire rope and physical or field conditions under which the mechanism is to operate has been based on rule of thumb, experience, and a relatively meager amount of factual data.

The degree to which field and operating conditions affect wire rope service still has to be determined by experience. In a general way, more flexible ropes are used as bending becomes the dominant factor. Less flexible ropes, with large outside wires, are desirable when the rope drags through or over abrasive material.

This article will attempt to introduce additional data relative to bending stresses which have been studied in the laboratory and field. Reference will be made also to existing design data and their relation to bending stresses.

Operating conditions already referred to for consideration include such items as

- bending stresses
- loading conditions
- portability
- corrosion
- abrasion
- rope speeds
- crushing
- material handled
- equipment design

As each of these factors will vary from job to job, it becomes necessary to evaluate the varying degrees of influence of each to the over-all design. For example, it would be impractical to install a six-foot drum on the back of a truck to handle a one-inch winch rope. Yet, on a mine hoist, such a drum would be standard practice.

Because of the many conditions that influence use and life of wire rope, there are a large number of constructions (number and arrangement of

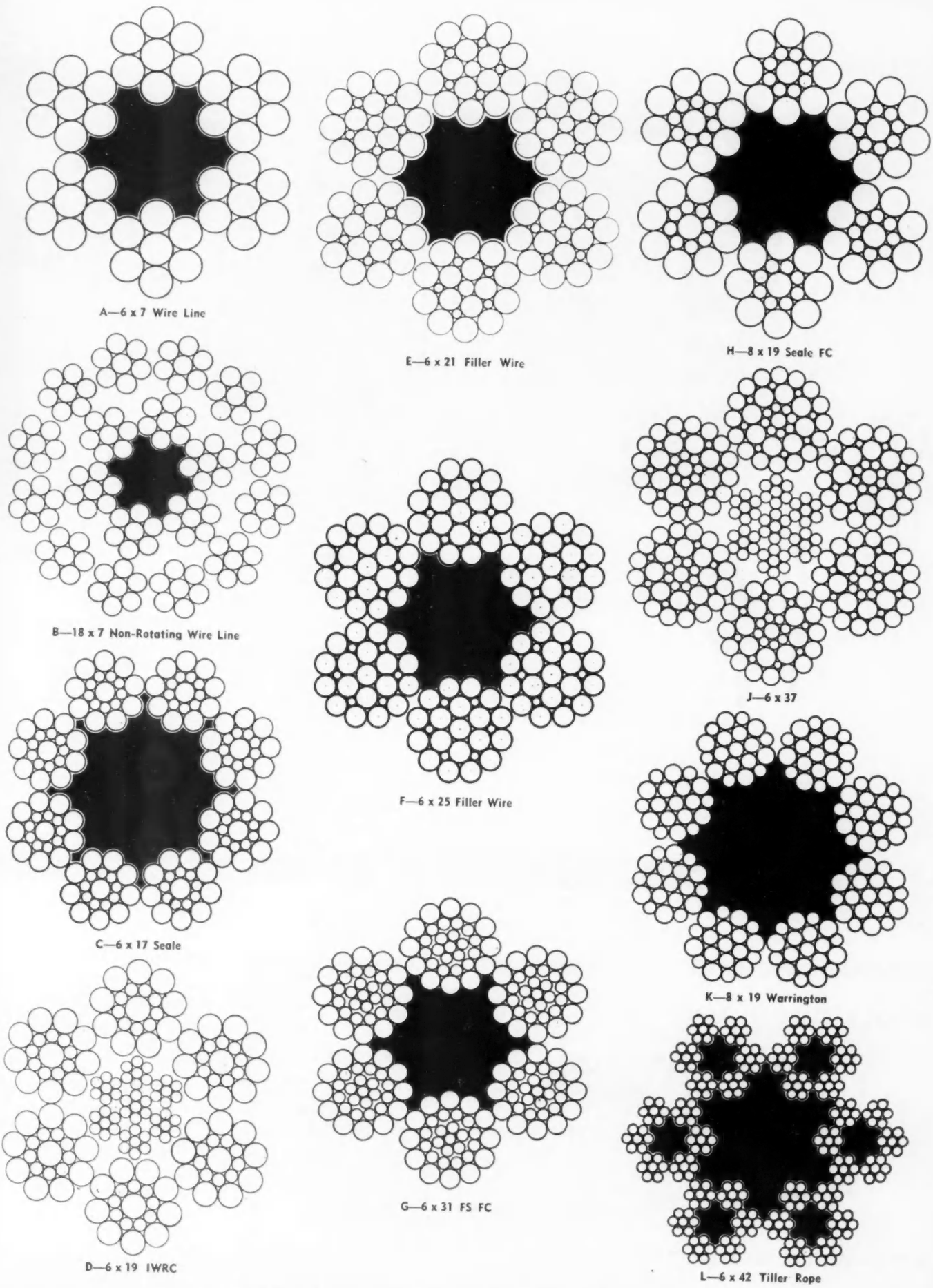
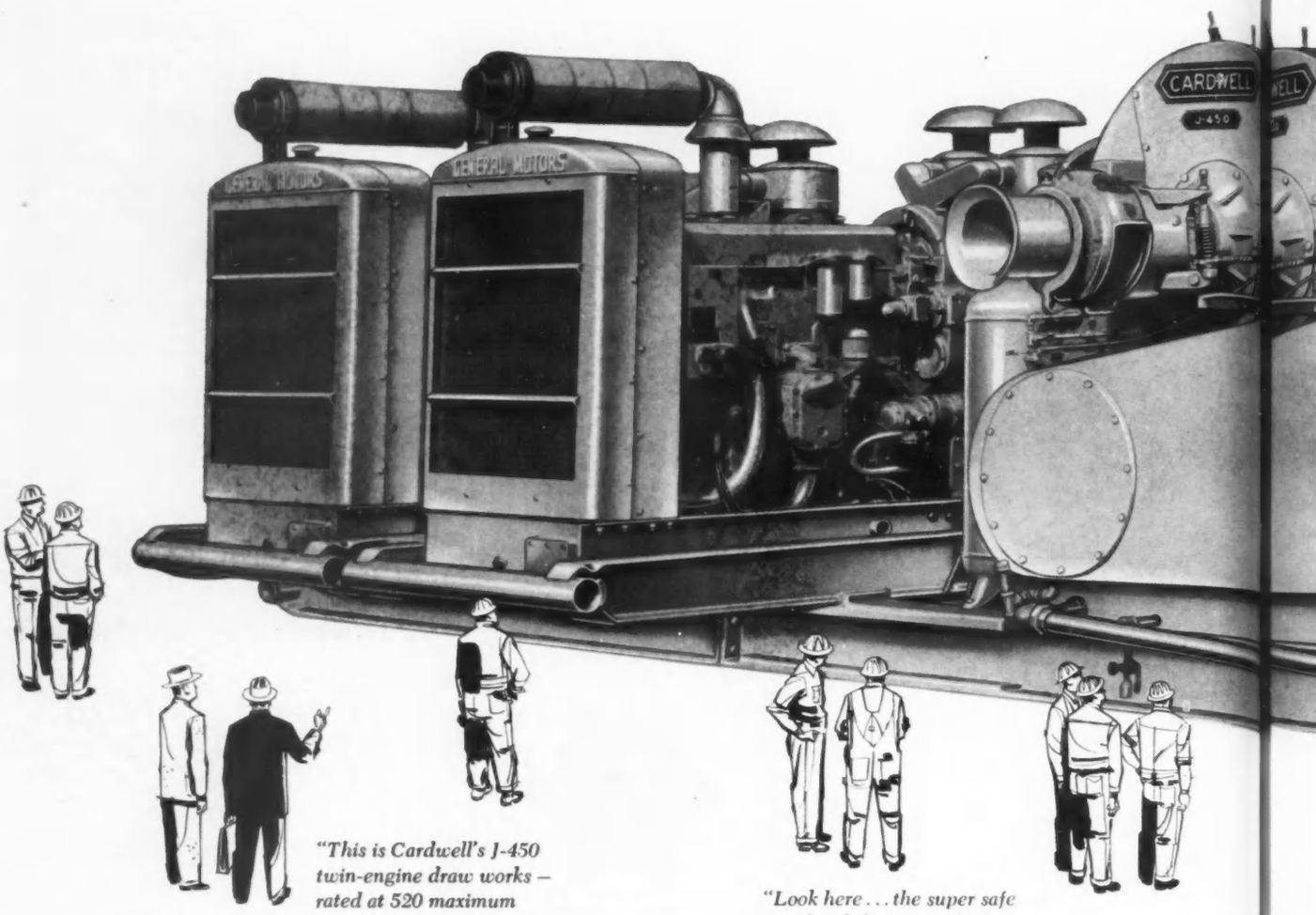

A—6 x 7 Wire Line
E—6 x 21 Filler Wire
H—8 x 19 Seale FC
B—18 x 7 Non-Rotating Wire Line
J—6 x 37
F—6 x 25 Filler Wire
C—6 x 17 Seale
K—8 x 19 Warrington
G—6 x 31 FS FC
D—6 x 19 IWRC
L—6 x 42 Tiller Rope

FIGURE 2—Design of the most commonly used wire rope constructions.



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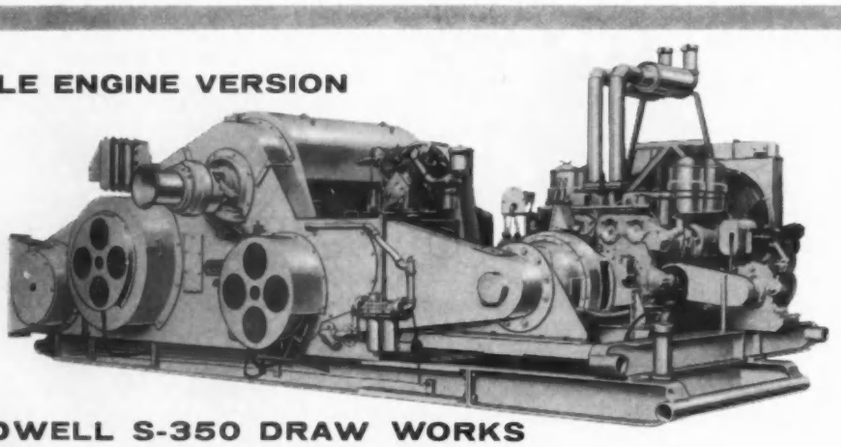

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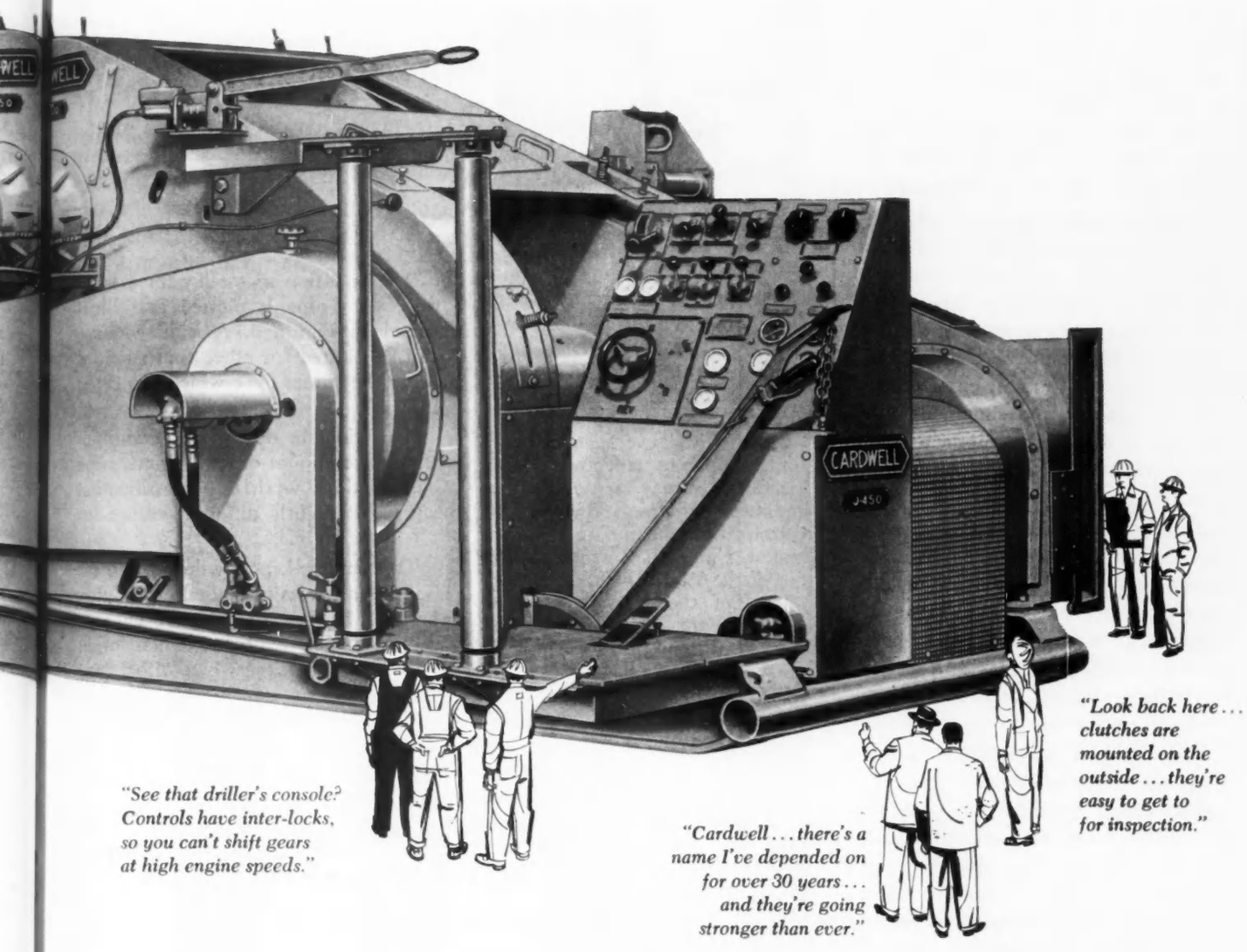

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wires in each strand as well as number of strands in the rope itself) that are used commercially. The most commonly used rope constructions are illustrated in Figure 2.

The constructions listed as well as many "specials" were developed to meet various operating conditions.

To design a practical machine which combines the expected field conditions and the proper wire rope construction requires considerable experience. Fixed sheave diameter to rope diameter and construction ratios have been used as a guide. In many cases, enterprising engineers and shopmen have successfully designed equipment with smaller ratios than those published as critical.

To take some of the projected engineering out of the picture, exhaustive bending tests have been made on the basic constructions shown in Figure 2. These tests were made under controlled conditions so that only bending stresses would be the primary cause of rope failure.

The fatigue machine on which these tests were made (see Figure 1) operated at a variable rope speed of 0 to 260 to 0 feet per minute for each half cycle. Tension was applied to the test ropes by means of hydraulic rams. The actual test consisted of operating the constructions under consideration at a uniform load, diameter ratio and speed as already noted. The ropes, in all cases, were given a double reverse bend between the three sheave set up. Variations were made in the D/d ratios by changing the sheave size.

Curves for each construction were drawn from the experimental data. Each curve thus plotted followed very closely a simple parabola with the focal point on the Y-axis. Comparisons between the various curves revealed the interesting fact that a similar relationship between constructions were to be found in already existing recommended sheave diameters.

General equation for the parabolas as plotted is

$$x^2 = 2py \qquad (1)$$

where x = D/d Ratio (D = Tread Diameter of Sheave in Inches d = Nominal Rope Diameter in Inches)
y = Relative Service Lite
2p = A Constant c (See Table 1)

The equation $x^2 = 39y$ for a 6x25 filler wire rope is plotted and illustrated in Figure 3. A similar curve can be plotted for other constructions using the values for c which are listed in Table 1.

Variations in design and manufacturing techniques of the various rope constructions within a classification will yield slightly different values for the constant c.

It should be kept in mind that these parabolic curves are based entirely on bending fatigue and do not indicate service to be expected when other operating conditions which affect rope life are present. In any case, however, as the rope is flexed over sheaves and drums, bending stresses are set up which will have an influence on the rope life.

As the general equation for the curves is $x^2 = 2py$, (c_1/c_2) represents a ratio between the specific curves. It now becomes a simple mathematical problem to solve for the service life for each construction when the D/d ratio is held constant.

Then when x is constant

$$c_2y_2 = c_1y_1$$

$$y_2 = \frac{(c_1)}{(c_2)}\ y_1$$

$$\frac{c_1}{c_2} = f \text{ (See Table 2)}$$

$$\text{or } y_2 = fy_1 \qquad (2)$$

Likewise, when the service life is held constant for each construction, then y is constant and

$$\frac{x_2^2}{c_2} = \frac{x_1^2}{c_1}$$

$$x_2^2 = \frac{(c_2)}{(c_1)}\ x_1^2$$

$$\text{then } x_2^2 = x_1^2/f$$

$$\text{or } x_2 = x_1 m$$

$$m = \frac{1}{\sqrt{f}} \text{ (See Table 3)} \qquad (3)$$

Values for x_1 or y_1 can be read directly from the curve in Figure 3.

The 6x25 filler wire rope construc-

TABLE NO. 1
SERVICE LIFE CONSTANTS
$x^2 = cy$

Construction	c
6x7	68.4
18x7	58.2
6x17 Seale	53.4
6x19 Seale	48.8
6x21 Filler Wire	42.4
6x25 Filler Wire	39.0
6x31	35.8
8x19 Seale	34.2
6x37	29.3
8x19 Warrington	29.3
Tiller Rope	19.5

TABLE NO. 2
BENDING-LIFE FACTORS
For Values of f
When Using Curve of 6x25 FW

Construction	Factor (f) (c_1/c_2)
6x7	0.57
18x7	0.67
6x17 Seale	0.73
6x19 Seale	0.80
6x21 Filler Wire	0.92
6x25 Filler Wire	1.00
6x31	1.09
8x19 Seale	1.14
6x37	1.33
8x19 Warrington	1.33
Tiller Rope	2.00

TABLE NO. 3
BENDING-LIFE FACTORS
For Values of m
where $m = 1/\sqrt{f}$
When Using Curve of 6x25 FW

Construction	
6x7	1.325
18x7	1.221
6x17 Seale	1.170
6x19 Seale	1.118
6x21 Filler Wire	1.042
6x25 Filler Wire	1.000
6x31	.957
8x19 Seale	.936
6x37	.867
8x19 Warrington	.867
Tiller Rope	.707

About the Author

C. M. ZERR, chief engineer with Union Wire Rope Corporation, is a 1932 graduate of Stevens Institute of Technology with a degree in mechanical engineering. After graduation he worked with several construction companies and the U. S. Geodetic Survey. Hired as an engineer by Union Wire Rope Corporation, he became chief engineer in 1946. Zerr is a member of the Wire Rope Sub-Committee of the API and vice chairman of the Wire Rope Technical Board.

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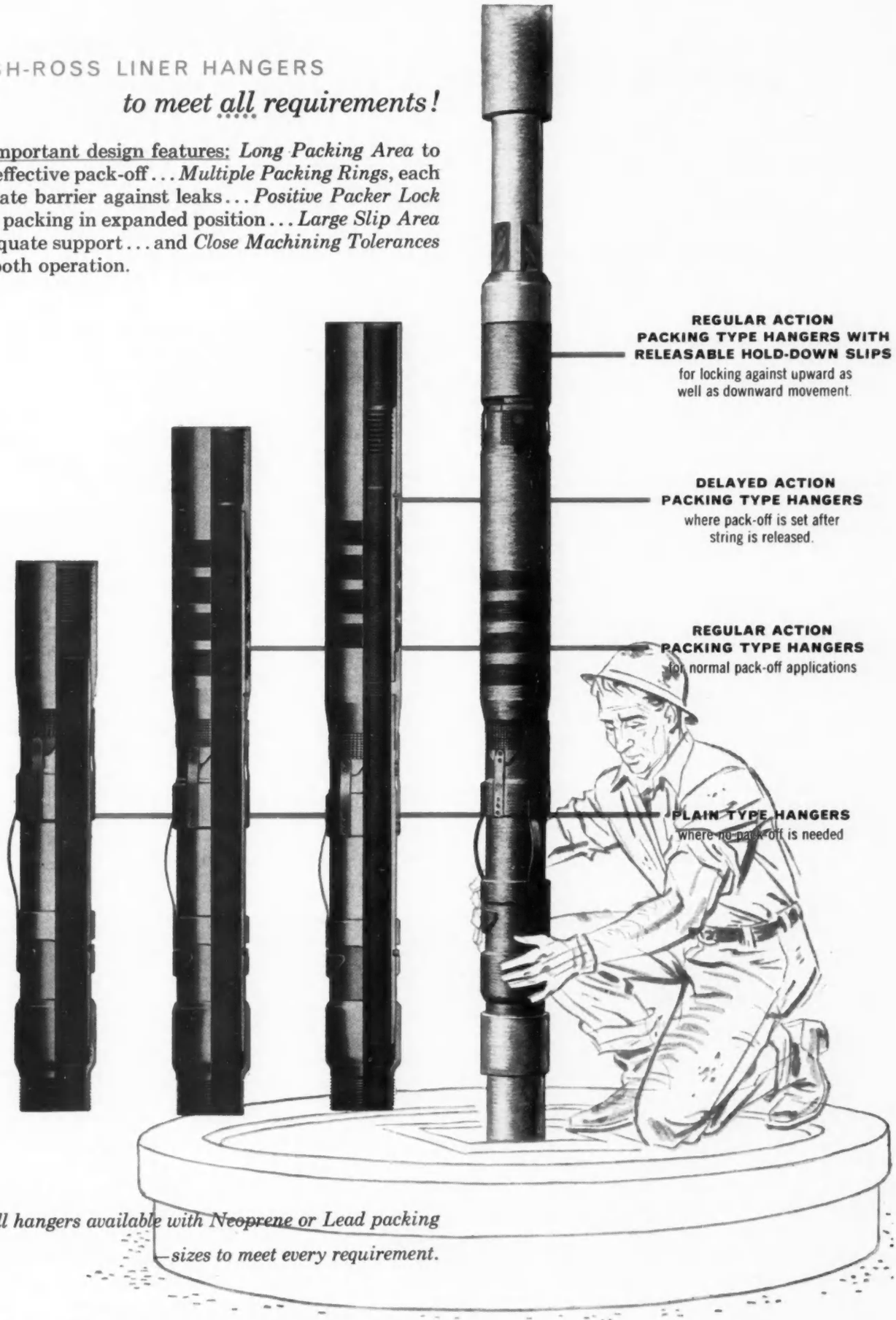

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tion was chosen arbitrarily as the basic rope for comparing other constructions or classifications for bending life. The values of Table 2 and 3 were thus established on the basis of their respective c values. The resulting factor "f" is an indication of the relative stiffness or flexibility of the constructions.

As an illustration of the use of the factors, it can be assumed that a 7/8-inch 6x25 filler wire rope operating over a 21-inch (tread diameter) sheave, the D/d ratio would be 21/.875 or 24. The relative service number (from the ordinate) would be 14.

If, on the other hand, it is found that bending is the weighted field condition and the other factors are insignificant, then a more flexible 6x37 classification can be used. In such a case the relative service number would be obtained by multiplying 14 (y_1) times 1.33 (f). The service life number would then be 18.62.

When other field conditions such as crushing and abrasion become the more important factors, then the designer turns to such a rope as a 6x17. In this case, the service life number for a 7/8-inch 6x17 operating over the same 21-inch sheave (D/d still 24) becomes the product of 14 (y_1) times 0.75 (f) or 10.22.

Where bending conditions over sheaves and drums predominate in controlling rope life, sheaves should be as large as practical. Consideration should be given to economy of design, portability and effect of inertia in design of the equipment. When conditions other than bending over sheaves predominate, as in the case of rotary lines and mining machines, size of the sheaves can be reduced materially without seriously affecting rope life.

As a preliminary guide to designers and users in selecting proper sheave size, the following recommendations are offered. On Figure 3, "Relative Service Curve for 6x25 Filler Wire," points 1 and 2 are spotted on the curve. Between these two points is the general purpose range for the 6x25 filler wire plotted (see Table 4).

Table 4 lists the general purpose range for the most commonly used

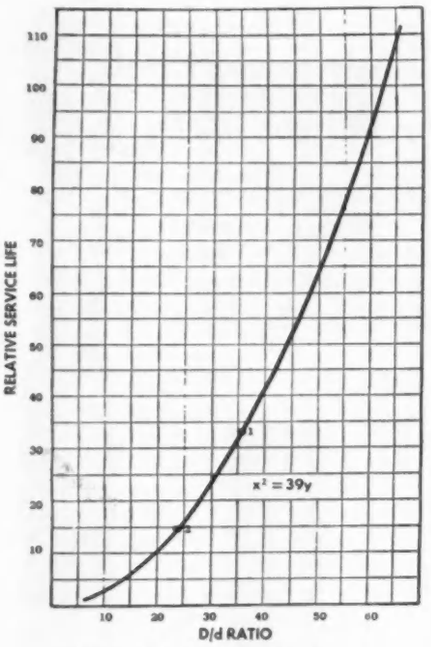


FIGURE 3—Relative Service Curve.

rope constructions. The factors n based primarily on bending stresses are expressed in terms of the ratio of sheave diameter to rope diameter (D/d). The following equation applies to the factors in Table 4.

$$D = d \times n$$

$$n = \frac{D}{d} \qquad (4)$$

where: D = Tread Diameter of sheave in inches

d = Nominal diameter of rope in inches

n = Sheave Diameter factor selected from Table 4

When it becomes expedient to go either above or below the general range, change in service life due to bending fatigue readily can be determined by using the basic equations,

TABLE NO. 4
SHEAVE DIAMETER FACTORS

Rope Construction	General Purpose Range D/d Ratios	
6x7	63	42
18x7	54	36
6x17 Seale	49	33
6x19 Seale	45	30
6x21 Filler Wire	39	26
6x25 Filler Wire	36	24
6x31	33	22
8x19 Seale	31	21
6x37	27	18
8x19 Warrington	27	18
Tiller Rope	18	12

Note: For determination of most appropriate values, refer to basic equations or the curve as plotted in Figure 3 and factors found in Tables 2 and 3.

or the curve, as plotted in Figure 3 and the factors of Tables 2 and 3.

In the lower range, difficulties will be experienced with the proper operation of the rope. Some of the more common ones are improper winding on the drum, crushing of the rope on the drum, excessive crown breaks, excessive valley breaks, curly ropes, increased sheave and drum wear (corrugations, etc.) and lower safety factor.

When using either the curve of Figure 3 or the values of Table 4, care should be exercised before finalizing the design. There are certain physical phenomenon beyond the effect of bending stresses which have an effect on service and safe operation of the rope. These must be considered.

Not all of the conditions which affect rope service can be discussed here. Many of them are of an indeterminate nature and can only be resolved by actual experience. Some of the conditions involve the human element which makes it very difficult to evaluate the end result. However, there is one condition that is closely related to the story of sheave size, and that is the material that is used for sheaves and drums.

A new rope, just installed, actually has only point contact between the wires along the crown of the strand and the score of the sheave. Shortly, the points wear down to small areas.

This wear is the result of the rope sliding over the sheave and drum grooves when loads are applied. The small elliptical shaped areas observed in Figure 4 represent the concentrated areas over which the radial forces are spread. As the rope continues to wear, these areas increase until the wire is worn half way through. When the material of the sheave is too soft, corrugations appear in the bottom of the groove, or both the groove and the rope wear down together so that a new rope will be pinched in the now undersize groove. This is illustrated in Figures 5 and 6.

In this and other similar cases, the soft sheave acts much as a grinding wheel, rapidly abraiding the rope.

Use of harder materials in the sheaves and drums has been successfully demonstrated under field conditions. These installations do not wear

avoids trouble in deep hole testing

HALLIBURTON'S EXPANDING SHOE PACKER

Easier, faster and more successful testing results from the Packer that's built to avoid trouble

- **Less Drag in and out of Hole**

  ...because the amount of drag is decreased by using a smaller diameter Packer than would normally be required.

  ...because pulling and jarring to release the Packer are minimized.

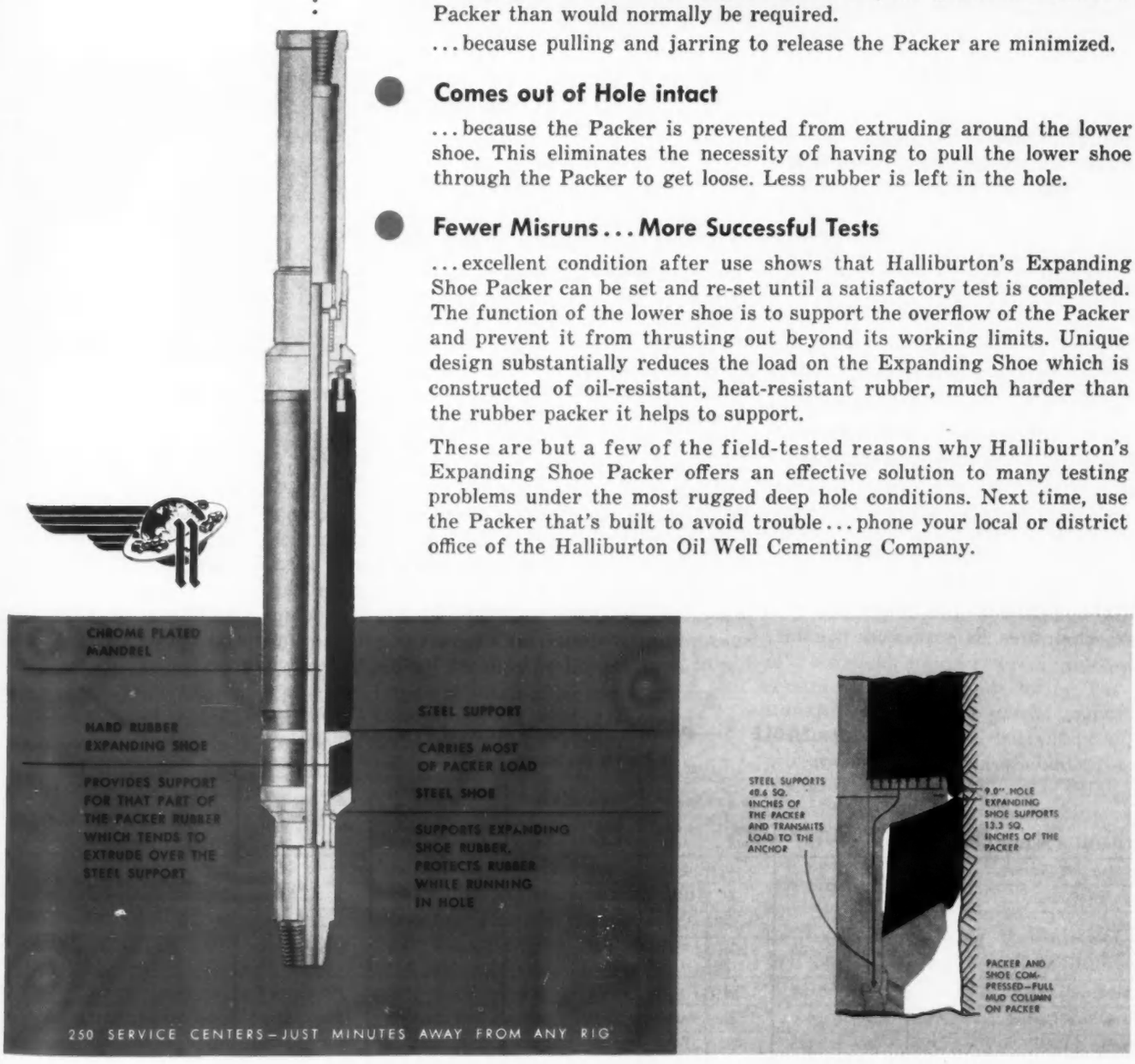
- **Comes out of Hole intact**

  ...because the Packer is prevented from extruding around the lower shoe. This eliminates the necessity of having to pull the lower shoe through the Packer to get loose. Less rubber is left in the hole.

- **Fewer Misruns... More Successful Tests**

  ...excellent condition after use shows that Halliburton's Expanding Shoe Packer can be set and re-set until a satisfactory test is completed. The function of the lower shoe is to support the overflow of the Packer and prevent it from thrusting out beyond its working limits. Unique design substantially reduces the load on the Expanding Shoe which is constructed of oil-resistant, heat-resistant rubber, much harder than the rubber packer it helps to support.

These are but a few of the field-tested reasons why Halliburton's Expanding Shoe Packer offers an effective solution to many testing problems under the most rugged deep hole conditions. Next time, use the Packer that's built to avoid trouble... phone your local or district office of the Halliburton Oil Well Cementing Company.


CHROME PLATED MANDREL
HARD RUBBER EXPANDING SHOE
PROVIDES SUPPORT FOR THAT PART OF THE PACKER RUBBER WHICH TENDS TO EXTRUDE OVER THE STEEL SUPPORT
STEEL SUPPORT
CARRIES MOST OF PACKER LOAD
STEEL SHOE
SUPPORTS EXPANDING SHOE RUBBER, PROTECTS RUBBER WHILE RUNNING IN HOLE
250 SERVICE CENTERS—JUST MINUTES AWAY FROM ANY RIG
STEEL SUPPORTS 40.6 SQ. INCHES OF THE PACKER AND TRANSMITS LOAD TO THE ANCHOR
9.0" HOLE EXPANDING SHOE SUPPORTS 13.3 SQ. INCHES OF THE PACKER
PACKER AND SHOE COMPRESSED—FULL MUD COLUMN ON PACKER

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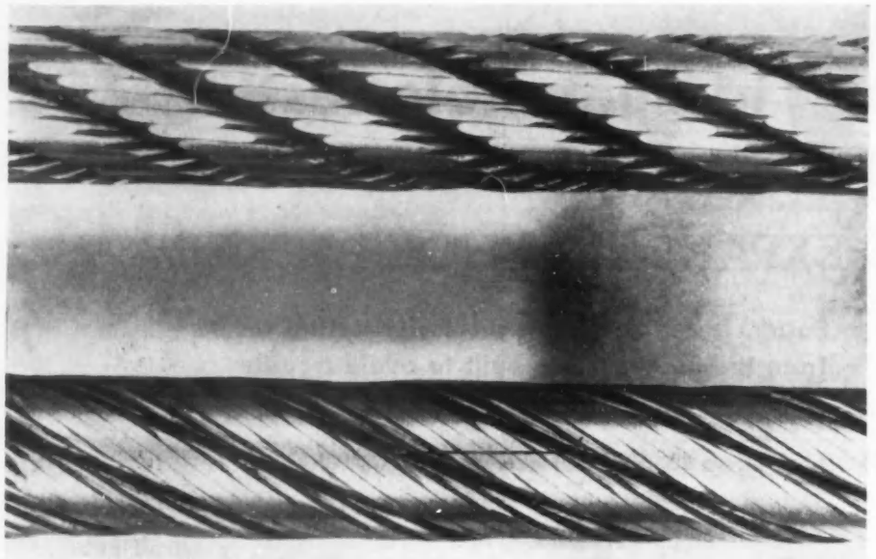


FIGURE 4—Worn wire line showing areas of contact.

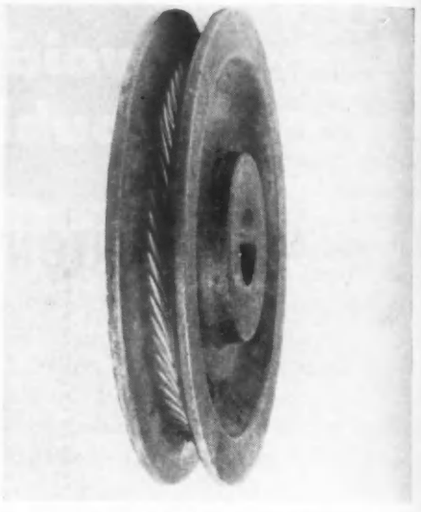


FIGURE 5—Corrugated sheave.

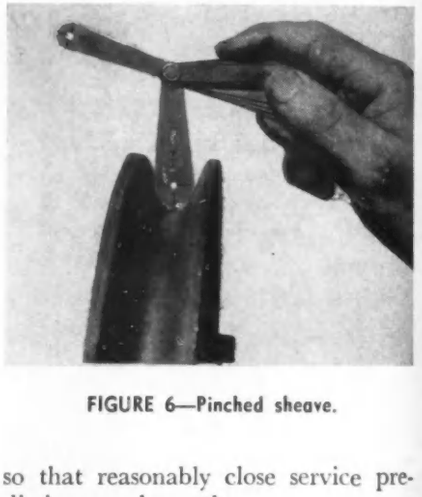


FIGURE 6—Pinched sheave.

down as rapidly nor corrugate under existing unit pressures. Tool steel sleeves, properly grooved, have been used as a lagging on worn out drums. This practice has practically eliminated further maintenance on the drum.

Larger sheaves will reduce the unit pressure by introducing more points of contact between the rope and sheave. The increased area thus obtained will reduce the wear and will affect a decrease in bending stresses. Unfortunately, it is not always possible to install these larger sheaves.

The unit radial pressure (p) expressed in pounds per square inch of projected area is expressed by the equation:

$$p = \frac{2T}{Dd}$$

where p = Pounds per square inch of projected area of rope
T = Tension in rope, in pounds
D = Tread Diameter of sheave, in inches
d = Diameter of rope, in inches

Table 5 has been prepared to give the permissible unit radial pressures for various materials of which sheave or sheave linings are made and rope constructions.

All factors which influence service life of wire rope are constantly at work, each one varying in relation to the others as operating conditions vary. An attempt has been made here to clarify one phase of the operational characteristics of wire rope. This phase, the influence of sheave diameter and material on the service life of wire rope, has been set forth so that reasonably close service predictions can be made.

It should be pointed out again that this article just covers bending stresses and sheave material. Other factors, some of which are itemized in the introduction, should not be ignored in the complete analysis of an application of wire rope.

TABLE 5—Permissible Unit Radial Pressures
In Pounds per Square Inch

Material of Sheave Groove	6 x 7		6 x 19 Seale		6 x 25 FW		6 x 37		8 x 19 Seale		Remarks
	Reg. Lay	Lang Lay	Reg. Lay	Lang Lay	Reg. Lay	Lang Lay	Reg. Lay	Lang Lay	Reg. Lay	Lang Lay	
Rubber and Leather	60	....	....	....	100	....	....	....	....	....	Rope bears on edges of packed laminated pieces set in sheave groove.
Canvas (Compr.)	120	....	....	....	200	....	....	....	....	....	
Leather	150	....	....	....	250	....	....	....	....	....	
Wood	150	165	200	220	250	275	300	330	350	385	End grain of beech, gum, hickory.
Cast Iron	285	315	380	425	475	525	570	625	665	730	
Carb. Steel Casting	540	600	720	800	900	1000	1080	1200	1260	1400	.30-.40 C.
Chilled C.I.	660	725	880	970	1100	1210	1320	1450	1540	1700	Not advised unless of uniformly hard.
Manganese Steel	1500	1650	2000	2200	2500	2750	3000	3300	3500	4000	Grooves should be ground.
Chromium Alloy	....	....	....	....	4000	....	....	....	....	....	Heat treated.

Increase all the above values by 10% for rope 1-inch diameter or smaller.

—The End

Put Your Stored Gas To Work . . . at a Profit

Stored gas can be put to work as an efficient means of recovering oil in deep-seated semi-depleted oil reservoirs.

By A. B. COOK, R. H. COULTER, JR., G. B. SPENCER, T. M. CHIN, and W. C. ELLIOTT, JR.
U. S. Bureau of Mines*

GAS-STORAGE operations in deep-seated oil reservoirs that have been semidepleted by primary production may prove to be an efficient new procedure for increasing oil recoveries in addition to being of value for storing gas. The new procedure has brought new problems to the reservoir engineer. A study was made to assist reservoir engineers in developing the best gas injection and production procedure, in estimating the gas-storage capacity of a reservoir, and the ultimate oil recovery resulting from gas-storage operations.

This study includes the performance to date of a reservoir, depleted by the primary-production procedure, that has been converted to use for gas storage. This reservoir, in the New York City oil field, Clay County, Texas, was discovered in 1941 when the Shell Oil Corporation completed its E. D. Coleman A-1 well. The reservoir is of the reef type, Mississippian in age, and approximately 6100 feet in depth. It is a closed dome-shaped reservoir and initially contained 7.3 million barrels of under-saturated reservoir oil, which is equivalent to 4,645,000 barrels of 47 API stock-tank oil. These values were obtained by using material-balance equations, utilizing data on a subsurface oil sample obtained by the Bureau of Mines in 1941, and the operator's production and reservoir-pressure data. The reservoir was depleted to a pressure of 144 pounds per square inch absolute by the solution gas-drive procedure with the production of 825,000 barrels of oil, amounting to 18 percent of that initially in place.

The Lone Star Gas Company acquired the New York City reservoir in 1952 for underground gas-storage purposes. After replugging all abandoned wells and reconditioning wells for the storage project, the reservoir was repressured to 2931 psia by the injection of 5087 billion cubic feet of natural gas. Gas cycling, after repressuring, resulted in the production of large quantities of oil and condensate. Indications are that gas cycling in combination with conventional gas-storage operations may result in additional hydrocarbon liquid recovery approximating that of primary production.

The study of the reservoir was expanded by experimentation with a laboratory reservoir during which the performance of the New York City field reservoir was simulated for primary production, repressuring with gas, and gas cycling. Wells were tested and surface samples of oil and gas were obtained after the reservoir had been repressured with gas. The oil and gas were recombined and stabilized at reservoir conditions of pressure and temperature at the time of sampling. PVT data were obtained on the liquid phase and showed that it was different from that of the initial reservoir oil, as the relative amount of gas in solution was considerably less.

A synthetic reservoir oil sample that had PVT properties approximately the same as the initial reservoir oil was prepared. A portion of the sample was charged into the laboratory reservoir, maintained approximately at the initial temperature and pressure in the field reservoir, and primary production, repressuring with gas, and gas cycling was conducted. Fifty-five percent of the stock-tank oil in place was produced during primary production (this unusually high oil recovery probably was due primarily to gravity drainage effects).

In addition, 16 percent of the initial stock-tank oil was produced during gas cycling. Another 15.2 percent of the stock-tank oil was produced as vaporized products while cycling 3.77 pore volumes of gas. This makes a total of 86.2 percent oil recovery during the experiment, leaving 13.8 percent residual oil in the reservoir. These laboratory data, along with some theoretical considerations, were used to calculate the probable secondary oil recovery during gas-storage operations in the New York City field and to present a guide for calculating future reservoir performances for other semidepleted oil reservoirs that may be converted to gas storage.

Theoretical considerations, regarding the flow and vaporization of oil in a reservoir during gas-storage operations, are presented. A large part of a semidepleted oil reservoir will be resaturated with liquid during gas-storage operations; the partial volume is dependent upon the percentage of propanes and butanes available in the reservoir compared to initial conditions in the reservoir. As dry injection gas travels through the reservoir, the gas becomes enriched due to vaporization of the lighter hydrocarbon components of the reservoir oil. In the reservoir, near the injection well or wells, the amount of liquid saturation will become less as gas injection continues.

This results from displacement and vaporization of oil by gas. Away from the injection well, near the outer edge of the reservoir, the amount of liquid saturation will become greater because oil has been forced into this

* Authors Cook, Coulter and Spencer are located in Bartlesville, Okla. Author Chin formerly at Bartlesville and now at Morgantown, W. Va. Author Elliott's address is Dallas, Texas.

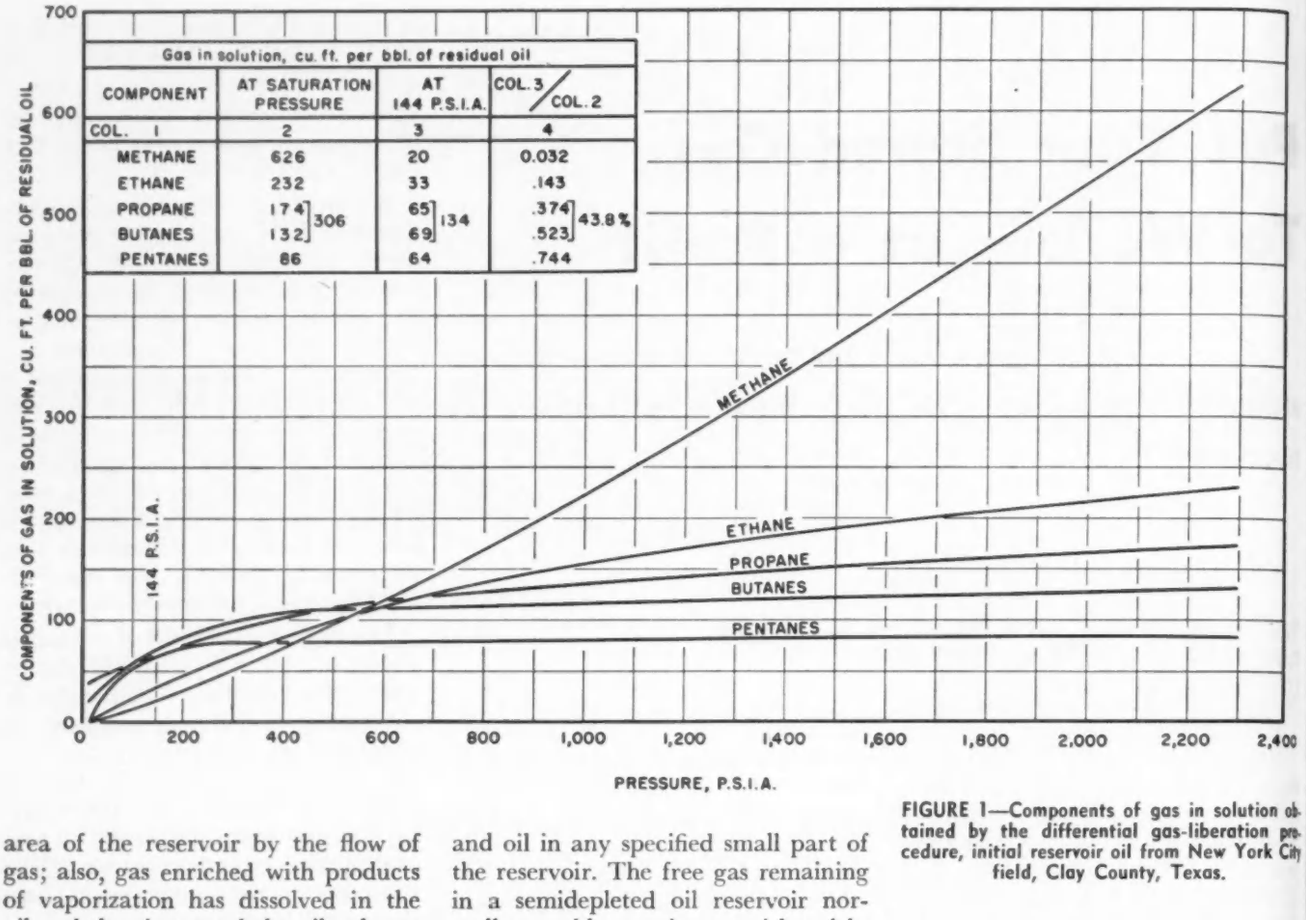


FIGURE 1—Components of gas in solution obtained by the differential gas-liberation procedure, initial reservoir oil from New York City field, Clay County, Texas.

area of the reservoir by the flow of gas; also, gas enriched with products of vaporization has dissolved in the oil and thus increased the oil volume.

Two major conclusions were drawn from the study. First, the selection of the respective positions of injection and producing wells on the storage-reservoir structure may affect materially the secondary oil recovery; and second, that more oil will be recovered by repeated gas injection and withdrawal in storage operation than by conventional gas cycling.

The study of the New York City field indicated that the expected oil recovery would have been almost doubled if the choice of injection and producing wells had been reversed. Also, in the normal operation of the gas-storage project, the reservoir will be subjected to annual pressure build-up and reduction which will assist in greater oil recovery from less permeable sections of the reservoir; these less permeable sections remain practically untouched in a conventional gas-cycling operation.

Distribution of Oil in Semidepleted Oil Reservoir After Repressuring With Gas. Laboratory experimentation by the authors and data obtained by other researchers[1, 2, 3] indicate that near equilibrium exists for the gas and oil in any specified small part of the reservoir. The free gas remaining in a semidepleted oil reservoir normally would contain considerably more LPG products than a dry gas used for repressuring. The first gas used for repressuring displaces reservoir gas and some oil away from the injection well. With continued gas injection the oil saturation in this area will be reduced to the extent that oil will no longer flow. As injection gas comes in contact with the immobile oil, vaporization of some of the oil occurs to establish equilibrium conditions between the oil and gas. The very first gas injected into the reservoir travels only a short distance before it becomes enriched with products of vaporization to the extent that its composition is the same as reservoir gas that has not been mixed with injection gas.

After a short period of gas injection the immobile reservoir oil near the injection well will have lost most of its LPG and natural gasoline products. Thus, as gas is continued to be injected it will travel farther from the injection well before it vaporizes enough reservoir oil to make its composition the same as that of the gas farther back from the injection well. Oil and gas will flow in a reservoir during repressuring with gas according to the relative permeability characteristics of the reservoir rock. Away from the injection wells the injected gas is expected to have become enriched to the extent that it is of the same composition, for comparable pressures, as free gas in the reservoir during primary production. Therefore, in this part of the reservoir the physical properties of the oil and the percentage liquid saturation of the reservoir should be the same, for comparable pressures, during gas repressuring as during primary production.

Part of the reservoir is expected to become 100 percent liquid-saturated when the reservoir pressure reaches that of the saturation pressure of the initial reservoir oil. Although this volume cannot be calculated exactly, a reasonable estimate can be made of the upper limit of the volume saturated. Reservoir oil consists of (1) dry gas, (2) LPG products, and (3) stock-tank oil. The volume of oil that would be formed during gas repressuring, with physical properties the same as the initial reservoir oil, could be limited by any of the three listed above.

However, the limiting factor to this oil volume normally will depend on the amount of LPG products left in the reservoir after primary production, because the amount of LPG products that had been produced was greater than the amount of stock-tank oil produced, on the basis of the proportionate amount of each initially present in the reservoir. The dry gas produced during primary production will be replaced with the injection gas.

The components of gas in solution for the New York City field were obtained by analyzing gas liberated from the initial reservoir oil by the differential—gas-liberation procedure. A plot (Figure 1) was made from these data, showing components of gas (methane through pentanes) in solution for pressures ranging from atmospheric to 2300 psia, the saturation pressure of the initial reservoir oil. A table is inserted in the figure showing the volume of each gaseous component in solution at two pressures, 144 psia (the reservoir pressure at the end of primary production) and 2300 psia (the saturation pressure of the initial reservoir oil). The last column in the table shows the percentage of each gaseous component at the end of primary production compared to that initially available, based upon one unit of residual oil. The values for propanes and butanes are lower than those of the heavier hydrocarbons; the composite average of the two is 43.8 percent. Therefore, the upper limit of the part of the reservoir that could be brought back to initial fluid conditions would be calculated as follows: 43.8 times the fraction of the stock-tank oil in the reservoir at the end of primary production (43.8 X 0.82 or 36 percent).

The above calculation did not consider propane and butanes in the gaseous phase left in the reservoir at the end of primary production or the propane and butane in the injection gas. If the injection gas contains appreciable quantities of propane or butane, this should be considered in the calculations. The authors believe that the part of the reservoir that will be completely resaturated with oil will closely approach that indicated by the method above for calculating the maximum volume. Apparently most of the propane and butane flowed to the outer edge of the New York City field reservoir during the period of repressuring the reservoir with gas. The analyses of both the reservoir oil and gas, obtained from the recombined separator samples after the field had been repressured with gas, showed that the fluids contained only small amounts of propane and butane (see Table 1).

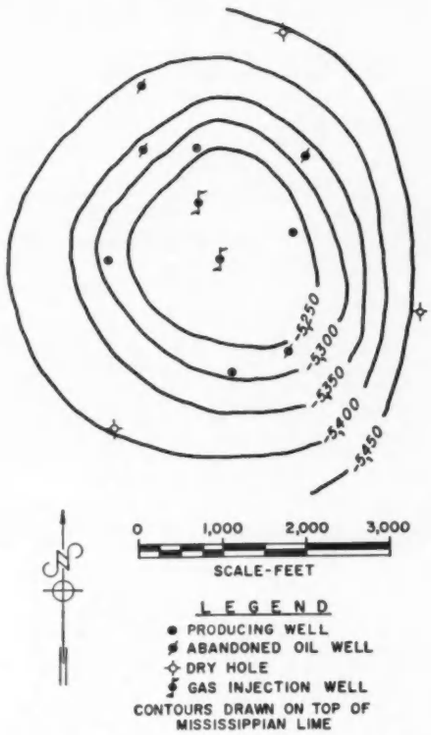


FIGURE 2—Structure map of New York City field.

TABLE 1

Fractional analyses of separator oil and gas samples, and reservoir[1] oil and gas samples, New York City field, Clay County, Texas.

COMPONENT	High-Pressure Separator (328 p.s.i.a. and 60° F.)		Reservoir (2,712 p.s.i.a. and 164° F.)	
	Gas	Oil	Gas	Oil
	Mole Fraction			
Carbon dioxide	0.0015	0.0004	0.0010	0.0011
Nitrogen	.0172	.0134	.0247	.0067
Methane	.8553	.0819	.8312	.4105
Ethane	.0809	.0618	.0802	.0868
Propane	.0290	.0728	.0300	.0521
Isobutane	.0008	.0102	.0007	.0002
Normal butane	.0070	.0584	.0074	.0248
Isopentane	.0022	.0324	.0054	.0087
Normal pentane	.0025	.0609	.0043	.0177
Hexanes	.0036	.1415	.0031	.0385
Heptanes plus	.0000	.4663	.0120	.3529
Total	1.0000	1.0000	1.0000	1.0000
Specific gravity of C_7^+ residue	(2)	[3]0.7829	(2)	[3]0.8252
Molecular weight of C_7^+ residue	(2)	[4]169	[5]103.5	[4]189

[1] 328 p.s.i.a. separator oil and gas samples were recombined and adjusted to reservoir conditions of 2,712 p.s.i.a. and 164° F. to form both the reservoir oil and gas.
[2] Insufficient residue for determination of this value.
[3] Specific gravity from Hempel analysis of residue.
[4] Determined from plot of molecular weight versus specific gravity of similar crudes.
[5] Determined by vapor pressure method.

Gas Injection and Production Practice for Efficient Oil Recovery.

The New York City field is used here as a basis for suggesting gas injection and production practices that will result in maximum oil recoveries from semidepleted oil reservoirs that may be converted to gas storage reservoirs; the discussion is not intended to suggest that the gas injection and production practice be changed in the New York City field. Originally the New York City field was considered only for conversion into a gas-storage project. In retrospect, the authors believe that the reservoir could have been converted to gas-storage and operated in a manner that would have resulted in about doubling the secondary recovery of oil. This could have been done without reducing the value of the reservoir for gas storage.

The well locations in the New York City field are shown on the structure map in Figure 2. This map shows the two injection wells near the center of the field and the four producing wells about half way between the center and outer edge of the field boundary. The reservoir volumes inside and outside an imaginary smooth, circular-type curve drawn through the locations of the four producing wells are approximately equal.

Repressuring of the reservoir with gas caused part of the oil, from that part of the reservoir within the area enclosed by the four producing wells, to flow to the outer half of the reservoir. Laboratory and field production data indicate that, when the reservoir was first repressured with gas, the reservoir could be divided into the following three volumes according to liquid saturations:

- Completely saturated with liquid.
- Partly saturated with liquid to the extent that both gas and oil would flow through the reservoir.
- Partly saturated with liquid but with such a low liquid saturation that the liquid would not flow.

A more efficient and rapid oil recovery from New York City field would have resulted if the four wells designated producing wells had been drilled nearer the edge of the field and if the gas had been injected into the edge wells rather than those centrally located. The three schematic drawings of a semidepleted oil reservoir in Figure 3 exemplify the above statements. In these drawings the relative amount of oil saturation in any part

of the reservoir is illustrated by the height of the shaded area; where the shaded area extends to the top of the reservoir the liquid saturation is 100 percent. The upper drawing shows the reservoir, at the end of the primary production, with all parts of the reservoir being partly and equally liquid-saturated. The middle drawing shows the liquid saturation after the reservoir has been repressured with gas through the center opening. The parts of the reservoir containing oil of high enough liquid concentration so that the liquid will flow are primarily outside the two outside openings. The lower drawing shows the liquid saturation in the reservoir after it has been repressured simultaneously through the two outside openings. This shows the center and the two outer parts of the reservoir 100 percent liquid-saturated and with the center part equal to the total of the two outer parts.

The field maps presented in Figure 4 were constructed to apply the information presented above in Figure 3 to actual field conditions. The shaded areas on these two maps indicate the parts of the reservoir that are 100 percent liquid-saturated. Both Figures 3 and 4 illustrate that a greater and more rapid rate of oil recovery should result from repressuring through the edge wells of a field instead of through wells centrally located.

Oil Recovery During Gas-Storage Operations. Production data for the New York City field during the early stages of gas-cycling operations are given in Table 2. Changes in field-production gas-oil ratios apparently correspond to the pressure changes in the reservoir during the first year of gas-cycling operations. Changes in pressure cause two changes to occur in the reservoir fluids that influence the production gas-oil ratios:

- The flowing gas-oil ratio in the reservoir depends on the reservoir-liquid saturation, which depends on the reservoir pressure.
- The amount of condensate in the vaporized phase in the reservoir gas is directly related to the reservoir pressure.

The fact that the reservoir pressure has a large influence on production gas-oil ratios supports the assumption made that conditions of near equilibrium exist betwen oil and gas at any one location in the reservoir.

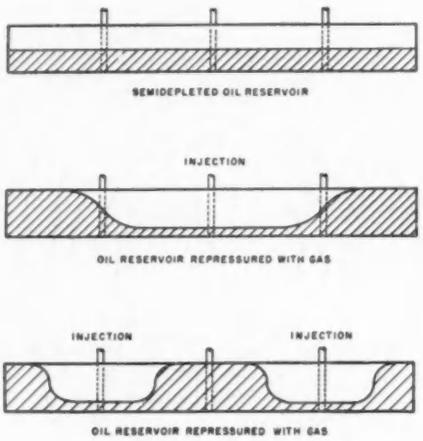
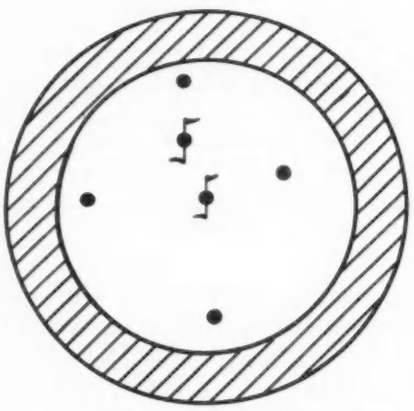


FIGURE 3—Idealized distribution of oil in semi-depleted oil reservoir. Shaded areas show relative oil saturation.



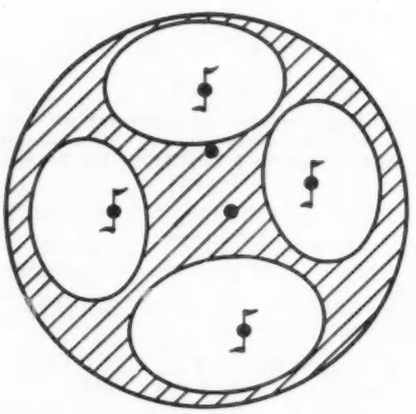


FIGURE 4—Probable distribution of oil in New York City field for two programs of gas injection.

Tests in the field in December, 1954 (soon after gas cycling was begun) and laboratory data obtained from recombined samples taken at that time showed that most of the stock-tank hydrocarbon liquid being produced was derived from oil vaporized in the reservoir. The volume of the reservoir being cycled was calculated to be about half of the total volume. From theory, field data, and laboratory data, it appears almost certain that oil flowed in the reservoir while it was being repressured with gas. It was estimated that possibly a third of the oil in the center half of the reservoir flowed as liquid or vaporized products to the outer half of the reservoir.

There were 1,910,000 barrels of stock-tank oil calculated by the material-balance method, left in the middle half of the New York City field at the end of primary production. If one-third, or 640,000 barrels of oil, flowed out of this part of the reservoir during the period of gas repressuring, two-thirds, or 1,270,000 barrels of oil, would be left in the center part of the reservoir. The laboratory data indicate that 53 percent of this available oil can be vaporized by gas-cycling operations. Thus, the expected recovery of oil from vaporization is 53 percent of 1,270,000 or 675,000 barrels. Little oil production resulting from the flow of liquid in the reservoir is indicated from either field or laboratory data.

Some oil in addition to the 675,000 barrels will be recovered under present operations of the New York City field reservoir. Because the field was designed and is used for gas storage, the pressure in the reservoir is reduced during the winter months by gas withdrawal and increased to a maximum again the next summer by gas injection. This results in a "breathing" effect in the reservoir that will cause some oil, both liquid and vaporized products, to be produced from the outer part of the reservoir. However, no method was devised for estimating the recovery from this source, so it is disregarded in this calculation. The estimated ultimate secondary-oil recovery under present operations for the field is 14.5 percent of that initially in place.

The hydrocarbon-liquid production from the New York City field resulting from gas cycling and storage operation was 145,000 barrels during the two years 1954 and 1955. Most of this production was obtained during conventional gas cycling at reservoir pressures between 3000 and 3150 psia. Only once during this period (in the winter of 1954-55) was the reservoir pressure reduced by withdrawal of gas from the field. The gas-storage and gas-cycling operation

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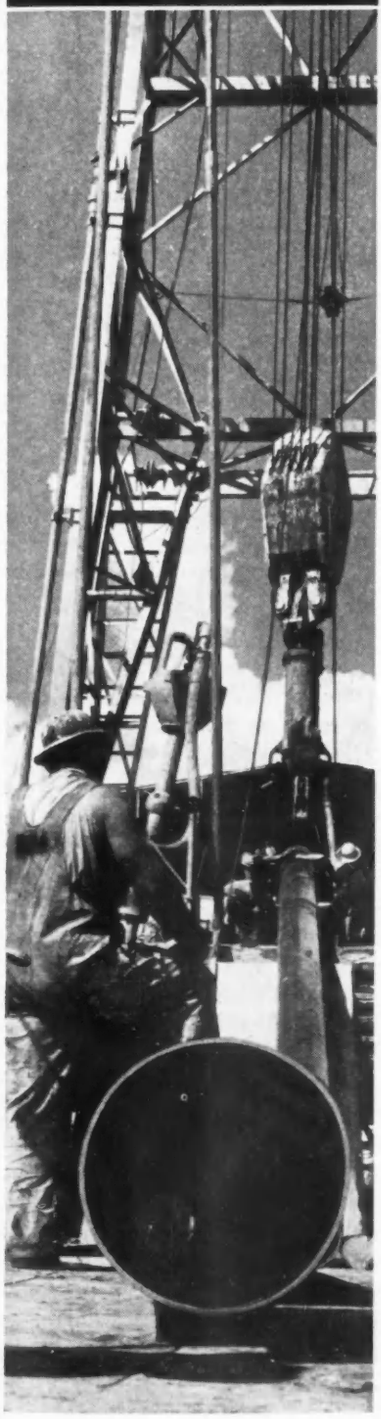

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data in Table 2 show that the gas-oil ratio has increased about 50 percent since cycling was begun to December 1955. With the production gas-oil ratio increasing about 50 percent for only 145,000 barrels of oil recovery, the above estimate of 675,000 barrels for the ultimate oil recovery by gas-cycling and storage operations would appear to be high. However, this gas-cycling operation has been at essentially constant pressure and has not utilized the more efficient 'batch-type" cycling operation that is natural to gas-storage operations.

It is of interest, especially to those interested in gas storage in semidepleted oil reservoirs, to calculate the ultimate oil recovery if the choice of injection and producing wells had been reversed. The following two basic assumptions are made:

- All parts of the reservoir within the area outlined by the four outside wells will be affected by the cycled gas.
- The percentage of oil recovery from the field will be the same as that from the laboratory reservoir, based upon the volume of oil left at the end of primary recovery.

An estimated 1,910,000 barrels of stock-tank oil were left in this center area of the reservoir. In the laboratory reservoir 70 percent of the oil remaining after primary production was produced, 36 percent as oil and 34 percent as vaporized products. Thus, the secondary-oil recovery would be 1,340,000 barrels.

In the above calculations it was assumed that no part of the reservoir was bypassed by the injection gas in its travel through the reservoir. The flow of fluids in a reservoir used for gas storage differs from that in reservoirs being gas-cycled. In normal gas-cycling operations, because the reservoir pressure is essentially constant, the major flow of gas is through the more permeable zones. When a reservoir is used for gas storage the operation becomes a "batch process" in which no wells are produced during the period of injecting gas and no gas is injected during the period of withdrawing gas. During the period of gas injection the reservoir gas flows into all parts of the reservoir regardless of variations in reservoir permeabilities. Likewise, during gas withdrawal from the reservoir there is an expansion and flow of the reservoir fluids toward the producing wells.

The recovery of oil from the New York City field would have been greater if the outer wells in the field had been nearer the field's edge, assuming that the reservoir rock was permeable enough to develop the desired productivity. Another procedure whereby the recovery would have been greater would have been to repressure the reservoir through only two outside wells on opposite sides of the reservoir. During the first stages of gas cycling these two wells would have been used for gas injection and the other two outside wells would have been used for production; the inside wells would have been shut in.

Through this type of operation some of the outer half of the reservoir would have been included in the sweep pattern of the cycled gas. This modification would have been in effect only during the early years of the gas-storage operations until production gas-oil ratios became excessively high. Then all four outer wells would be used for gas injection and the two center wells for production.

TABLE 2
Gas-storage and cycling operations in the New York City field, Clay County, Texas

DATE	Reservoir Pressure, p.s.i.a.	OIL PRODUCTION, Barrels		Oil Gravity, °API	GAS PRODUCTION, M Cu. Ft.		Gas-Oil Ratio, M Cu. Ft. per Bbl.	Net Gas Storage, M Cu. Ft.
		Month	Cumulative		Month	Cumulative		
1954								
July	2,520	582	582	56.2	18,200	18,200	31.3	4,474,436
August	2,945	211	793	...	33,300	51,500	...	5,086,974
September	3,070	4,682	5,475	...	137,800	189,300	29.4	5,346,975
October	3,060	10,903	16,378	...	273,900	463,200	25.1	5,465,349
November	2,940	15,806	32,184	...	495,200	958,400	31.3	5,408,223
December	2,435	11,960	44,144	56.0	617,200	1,575,600	51.6	5,105,326
1955								
January	2,090	8,572	52,716	...	496,000	2,071,600	57.9	4,192,365
February	2,005	5,243	57,959	...	416,400	2,488,000	79.4	4,015,253
March	2,110	181	58,140	...	14,500	2,502,500	80.1	4,344,809
April	2,475	.....	58,140	...	.....	2,502,500	...	4,765,181
May	2,780	.....	58,140	...	.....	2,502,500	...	5,280,181
June	3,145	536	58,676	...	18,700	2,521,200	34.9	5,760,802
July	3,150	12,987	71,663	...	429,900	2,951,100	33.1	5,760,186
August	....	15,694	87,357	...	560,300	3,511,400	35.7	5,757,302
September	....	14,864	102,221	...	588,600	4,100,000	39.6	5,747,225
October	....	15,199	117,420	...	624,700	4,724,700	41.1	5,745,520
November	....	14,230	131,650	...	616,200	5,340,900	43.3	5,744,157
December	....	13,206	144,856	...	641,800	5,982,700	48.6	.....

Procedure for Calculating Gas-Storage Capacity of a Semidepleted Oil Reservoir. An exact method for determining the amount of gas that will dissolve in the reservoir oil would be most difficult because of the complex variations in the PVT properties of the oil throughout the reservoir after repressuring with gas. The oil near an injection well will be stripped of its lighter liquid-hydrocarbon components. Oil at intermediate distances from an injection well will be stripped of some of these lighter components. Oil near the boundary of flow from an injection well will contain the lighter components stripped from the oil nearer the injection well; the saturation pressure of this boundary oil will be near the saturation pressure of the initial reservoir oil, which may be lower than the maximum pressure for gas storage.

Because of these indeterminate conditions, it was assumed that the same amount of injection gas would go into solution in the reservoir oil throughout the reservoir as would dissolve in the oil if it were in one huge PV cell, regardless of variations in physical properties of the oil. Errors from this assumption should be small as compared to other probable errors.

Gas-in-solution and relative oil volume curves shown in Figure 5 were constructed from laboratory data obtained by dissolving dry gas in reservoir oil. The laboratory procedure follows:

1. A PV cell was charged with a measured volume of oil similar in physical properties to initial reservoir oil of the New York City field.

2. Gas was liberated from the oil, and the sample was expanded until the PVT properties and relative volumes of oil and gas in the field reservoir at the end of primary production were duplicated (at 144 psia).

3. The free gas then remaining in the PV cell was completely dissolved in the oil when the pressure was raised to 198 psia.

4. Four separate measured volumes of dry gas were injected into the PV cell, and the resulting changes in liquid volumes and saturation pressures were determined.

Solution of dry gas into reservoir oil will differ in the field and laboratory; part of the field reservoir will become completely saturated with liquid when the pressure, during re-

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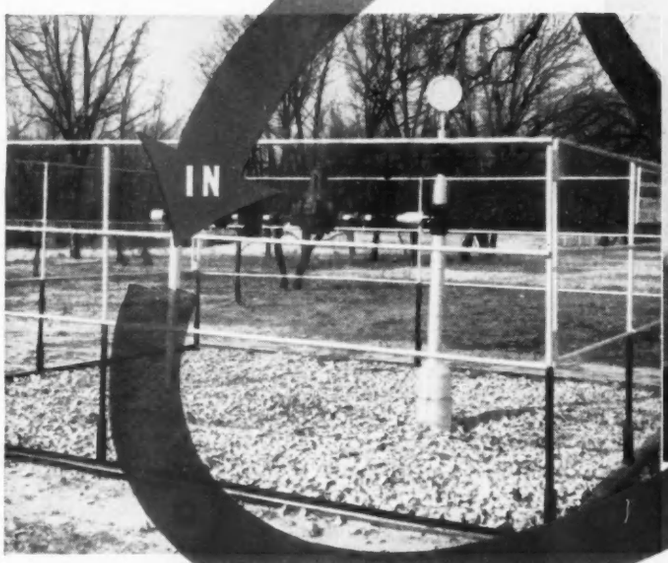
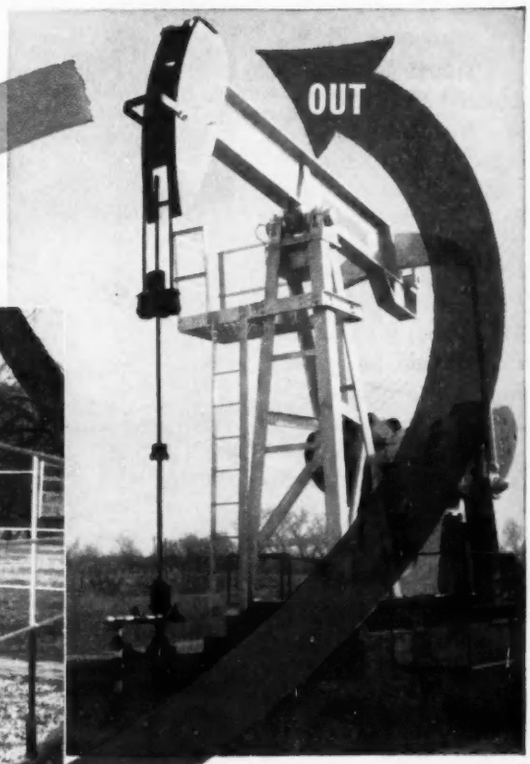


Water injection well



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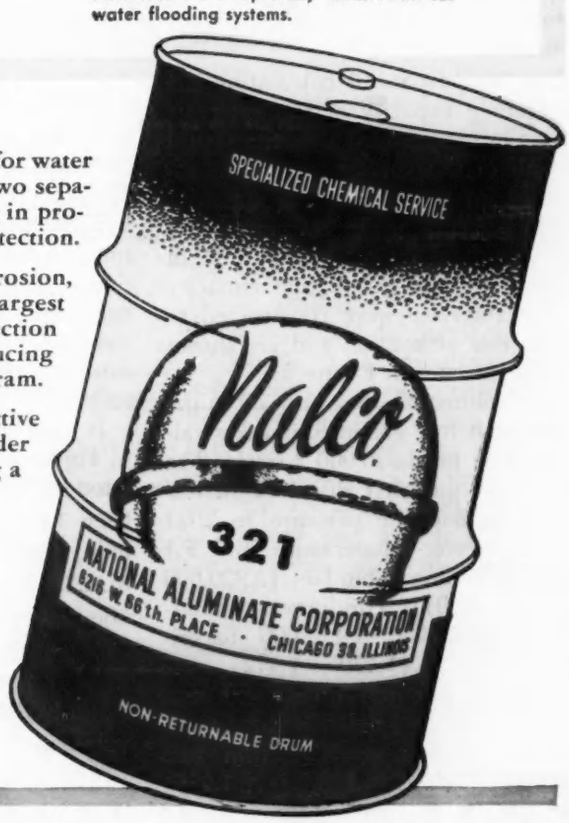

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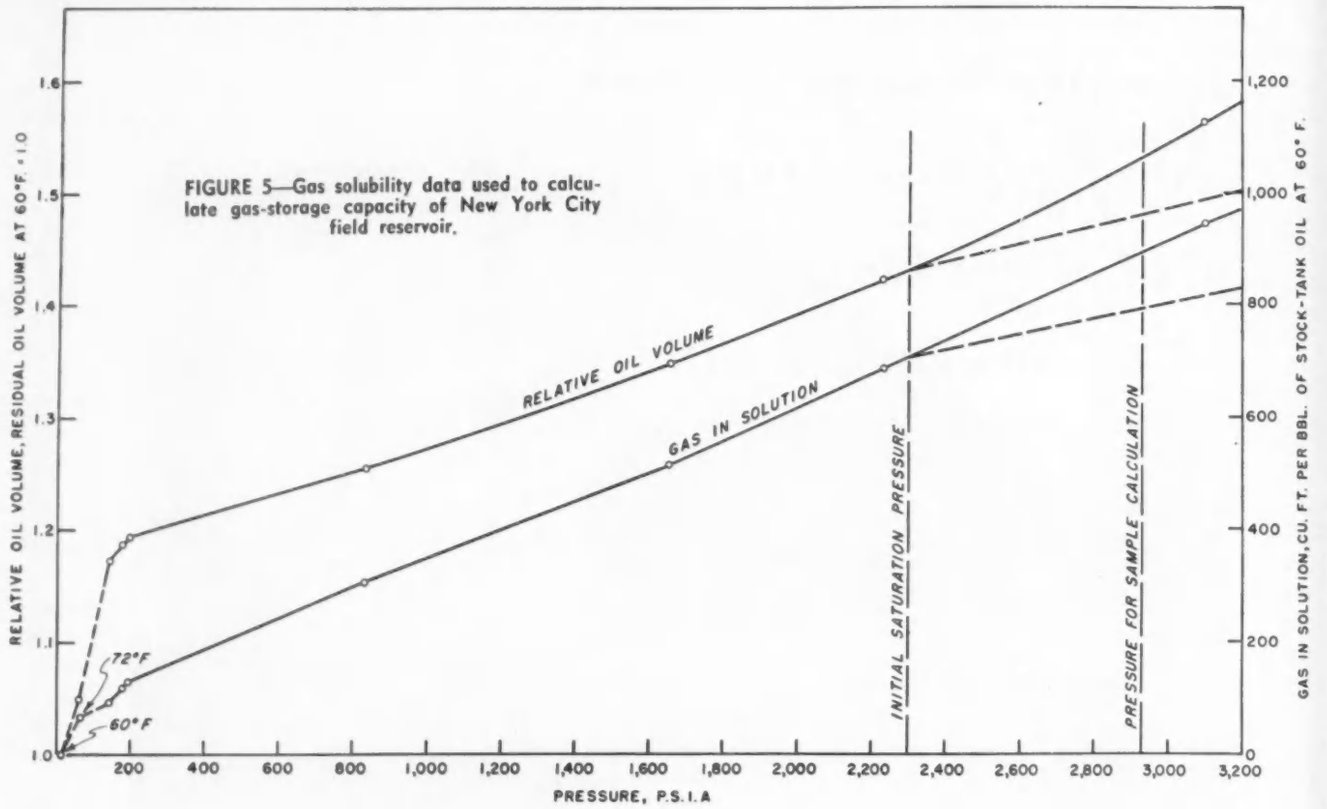

FIGURE 5—Gas solubility data used to calculate gas-storage capacity of New York City field reservoir.

pressuring, reaches the saturation pressure of the initial reservoir oil. Thus, additional injection of gas into the reservoir will cause gas to dissolve only in the oil in that part of the reservoir that is not completely liquid saturated.

For the purpose of calculating the gas-storage capacity of the reservoir it was estimated that the rate would be half of that indicated in the laboratory for pressures above the saturation pressure of the initial reservoir oil. The final curves to be used in calculating the gas-storage capacity of the reservoir were constructed to follow this estimation and are shown by dashed lines in Figure 5.

The volume of stock-tank oil in the reservoir before gas injection was calculated to be 3,820,000 barrels. The volume of gas that dissolved in this oil by raising the pressure to 2931 psia (reservoir temperature 164° F.) was 2.68 billion cubic feet [3,820,000 X (791 — 90)]. The increase in liquid volume was 1,173,000 barrels [3,820,000 X (1.479 — 1.172)]. As the initial reservoir oil volume was calculated to be 7,300,000 barrels and the oil volume at 2931 psia was 5,650,000 barrels (3,820,000 X 1.479) the gas in the free state occupied 1,650,000 barrels or 9,264,000 cubic feet. It was calculated that 193 cubic feet of dry gas at atmospheric pressure would be required to fill one cubic foot of reservoir space at 164° F. and 2931 psia.

Therefore, the equivalent standard cubic feet of gas in the reservoir in the free state was 1.788 billion (9,264,000 X 193). The total calculated volume of gas that dissolved into the oil and that remained in the free state was 4.466 billion cubic feet (2.678 + 1.788). This amount of gas includes the reservoir gas in the free state at the end of primary production which was about 130 million cubic feet. Thus, the calculated volume of injection gas necessary to raise the reservoir pressure from 144 to 2931 psia is 4,336 billion cubic feet.

If data from the upper set of curves in Figure 5 had been used, the calculated gas-storage capacity would have been 4.65 billion cubic feet, which is only slightly greater than the value of 4.336 billion cubic feet calculated above. If none of the gas had dissolved in the reservoir oil the calculated gas-storage capacity would be 2.926 billion cubic feet for the reservoir pressure of 2931 psia.

The greatest probable source of error in calculating the gas-storage capacity of a semidepleted oil reservoir is in determining the volume of the reservoir that is gas saturated prior to gas injection. Choosing the correct gas-solubility data for the reservoir oil is important but not as important as knowing the correct volume of the reservoir occupied by gas. Where it is impractical to obtain gas-solubility data in a laboratory by dissolving lean gas in the reservoir oil, estimations of the gas-solubility characteristics may be substituted.[4, 5, 6]

The gas-storage capacity will be increased about 1000 cubic feet from each barrel of hydrocarbon liquid produced. If all of the oil were removed from the reservoir, its gas-storage capacity would be about 7.9 billion cubic feet at 2931 psia.

ACKNOWLEDGMENT

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—**The End.**

A wire brush can be an important tool when it comes to protecting tubing threads.

How to Care for And Run Tubing

Design and manufacturing factors are important, but proper care of threads and proper make-up will assure long trouble-free service.

By R. J. STOUP
Spang-Chalfant, Tulsa

PROPER CARE of tubing threads, including cleaning, lubricating, adequate torque make-up, and careful handling when running tubing, will reward the operator with longer trouble-free service. Damaged threads can result in the loss of a joint of tubing. There are a number of basic and elementary precautions to be observed by all personnel that handle tubing, whether transporting it or running it into a well. These precautions will pay dividends if they are observed and carried out.

From an engineering standpoint there are three major factors that control the effectiveness and life of tubing and tubular goods on the lease:

- Design
- Manufacture
- Handling

Design is the mutual responsibility of the maker and the user. Correct manufacture of the tubular material is responsibility of the pipe fabricators who, for the most part, are living up to this responsibility. Proper handling of the product, while of prime interest to the fabricator and the seller, is essentially the responsibility of the operator and his field personnel.

The following recommendations for the care and running of tubing are based on observations and experience of both manufacturers and the large users.

Care Prior to Running Tubing. Inspection of the connections before going into the hole is very important. Protectors should be removed from the field and coupling ends of the tubing and the threads inspected just prior to running the tubing. A visual inspection of the threads will show whether they are properly coated with lubricant and whether or not dust or sand has sifted into the connection. If foreign matter is present, clean the pipe and coupling threads and apply fresh compound to all mating surfaces when the threads are dry.

If threads appear clean and undamaged, it probably is better to run tubing as it is received from the mill rather than attempt to perform a haphazard job of cleaning and re-doping. It is good practice in any case to apply additional thread compound just before stabbing.

Checking the tubing with an API drift prior to the initial run or when it has been exposed to excessive pulling or bending stresses is a good practice. This insures free passage for pumps, swabs, etc., through each separate joint. An API drift is 42 inches long and slightly smaller than the nominal inside diameter of the tubing.

Exact decimal values of the drift diameter for various tubing sizes are as follows:

1. 901 inches for 2⅜ inch OD upset or non-upset tubing.
2. 347 inches for 2⅞ inch OD upset or non-upset tubing.
3. 867 inches for 3½ inch OD upset or non-upset tubing.

There are a number of reasons why

tubing may not permit passage of a drift bar besides improper manufacture. Dints received during transport, tong crushing, and short kinks due to handling damage all can cause small restrictions. Thread and drift inspection are not intended as a check on the pipe manufacturer's inspection, but rather to be sure the material has not suffered damage after leaving the mill.

Before running the pipe inspection of the handling tools should not be neglected. Elevators should be in good condition and have links of equal length. Heavy safety elevators and spiders are recommended for long strings. Properly fitting tubing tongs should be used for making up tubing rather than pipe wrenches. Wrenches tend to crush the pipe and reduce its inside diameter.

When pulling tubing into the derrick, care should be taken to prevent excessive bending and to see that couplings or protectors are not bumped. Above all, tubing should be handled with thread protectors in place until ready to stab.

Care During Running of Tubing: The recommended series of operations for running tubing is something like this:

When the length of tubing is ready to stab, then remove the protector from the field end. Apply thread compound if it is necessary. When not in use, the compound should be kept in a closed container and the brush kept clean. Never thin the compound. As far as the kind of compound is concerned, there are no specific recommendations. It may be noted, however, the API has tested and made available to the industry a compound recommended for high pressure service.

A satisfactory compound should possess at least two properties.

1. Ability to lubricate the thread surface to facilitate joint make-up and breakout without galling.

2. To seal voids between the mating thread surfaces and prevent leakage. Obviously, if the lubricant is dirty or adulterated with sand it can do neither of these.

Properly cut API threads are quite resistant to leakage when properly made up. Under adverse field working conditions this is not always true, and considerable trouble is encountered in high pressure wells. Several patented tubing joints have been designed in which there is a positive metal-to-metal or gasket seal. These do not depend on a lubricant to prevent leakage, and have been used successfully for many years.

Objections to their use revolve around their greater cost and the fact they have never become an API standard, hence not interchangeable, one mill with the other.

When stabbing, the tubing should be lowered carefully to avoid injury to the threads. Stab vertically, preferably with the assistance of a man on the stabbing board. If tubing tilts to one side after stabbing, it should be lifted up, cleaned and any damaged threads corrected with a three-cornered file. Any filings should be carefully removed and compound reapplied over the thread surface.

Care should be exercised especially when running doubles or trebles to prevent bowing and resulting errors in alignment when the tubing is allowed to rest too heavily on the coupling threads. Intermediate supports may be placed in the derrick to limit bowing. This may even be advisable in running single lengths, if high winds are present.

After stabbing, the tubing should be made-up slowly by hand or by applying regular or power tubing tongs slowly. Power tubing tongs are recommended for high pressure or condensate wells to insure uniform make-up and tight joints.

One major oil company, operating largely on the Gulf Coast, has adopted an interesting technique for improving leakage in high pressure wells. This operator orders his couplings on tubing "handling tight," which is approximately one turn beyond hand tight, or he orders the couplings separately.

Then to insure tight joints, just before running, couplings are removed and both pipe and coupling threads are thoroughly cleaned and inspected. Thread compound is applied to both external and internal threads and the coupling reapplied "handling tight."

When this procedure is used, the coupling will "float" or make up simultaneously at both ends until the proper make-up is obtained. One very common question has been, "What are recommended torque figures using power tongs?" A proper answer to this might be as follows:

On an API connection, tightness is achieved when the face of the coupling covers the pipe threads. Experience might indicate a tight joint with one or two threads exposed, but any great variation from one joint to another in the same tubing shipment should be cause for investigation. In other words, in such cases back out the joint and examine the threads for damage.

To reach ideal tightness on a connection with power tongs, no maximum torque has been or can be established. However, field observation of a number of strings has indicated the following torques usually produce satisfactory results:

Size	Minimum	Maximum
2⅜" O.D.	1000 ft. lbs.	1400 ft. lbs.
2⅞" O.D.	1200 ft. lbs.	1600 ft. lbs.
3½" O.D.	1500 ft. lbs.	2200 ft. lbs.

This will vary with (among other things) the type of thread dope used.

The same hypothesis has been stated in a little different way by a prominent service company who reported its practice to an API committee as follows:

"Torque is not the sole measure of joint make-up, but should be used in conjunction with make-up position.

(a) If the average torque is reached at the time the coupling is at the last scratch, that is ideal.

(b) If the average torque is not reached when covering the last scratch, cover two turns if necessary.

(c) If covering the last scratch two turns does not develop the minimum torque, we recom-

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mend the connection be broken out.

(d) If the average torque is reached and several threads of the pipe remain exposed, proceed to the maximum torque. In the event the maximum torque leaves more than three threads exposed, we recommend the joint be broken out. It has been our observation that regular mill joints make up remarkably uniform."

Care During Pulling. There are many precautions which should be used in pulling tubing. In the first place, the breakout tongs should be positioned close to the coupling. When a jar or shock of some kind is necessary to start the unscrewing the coupling should not be pounded, especially near the ends. Using the flat fact of a ball-peen hammer, the coupling is tapped at the center and completely around its circumference. Great care should be exercised to disengage all of the threads before lifting out of the coupling. The tubing is not jumped out of the coupling.

Tubing stacked in derricks should be set on a wooden platform as steel or concrete may damage the threads. All threads should be protected with compound and thread protectors unless the tubing is to be re-run immediately.

When tubing is stuck, the best practice is to use a calibrated weight indicator. Tubing can be stretched an amazing amount and, unless a load indicator is used, one cannot be sure when the maximum tensile load has been applied. Amount of load which will cause a permanent set in the tubing for both upset and non-upset material may be found in API Bulletin 502.

While the foregoing recommendations mainly apply to tubing, they can be applied equally well to casing. Casing is heavier and larger, but the threads are not proportionately more rugged; so even more care in handling is indicated. Furthermore, casing is easier to dinge and should not be unloaded by dropping.

ACKNOWLEDGMENT

This article is based on a paper presented at the Oil Lift Short Course sponsored by Texas Technological College, Lubbock, Texas.

NOMOGRAPHS MAKE

Here's how to estimate oil and gas in place and the recoverable reserves without extensive calculations.

By KEITH D. SHEPPARD
Senior Production Engineer
Continental Oil Company, Denver

FREQUENTLY DURING a conference or a meeting, the reservoir engineer is called upon for facts and figures that may, and perhaps should, be at his fingertips. Among these will be estimates of oil or gas in place and recoverable oil or gas.

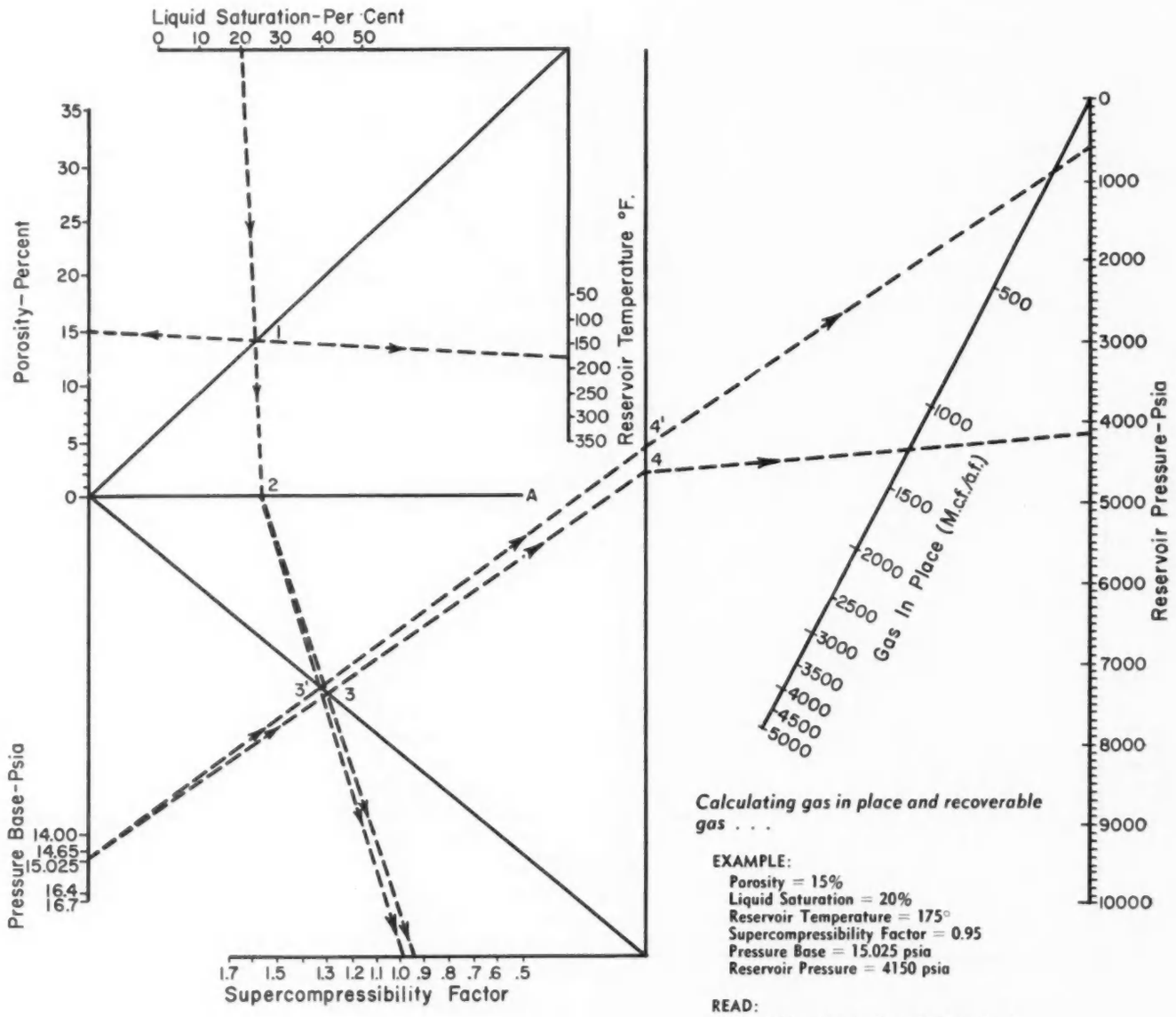
To assist the engineer in making these calculations rapidly with the utilization of a straight-edge rather than a calculator or slide rule, nomographs have been constructed for the solution of the familiar volumetric gas and oil equations:

$$V_g = C_1 \phi (1 - S_1) \frac{P_r}{P_b} \frac{1}{T_r} \frac{1}{Z_r}$$

$$V_o = \frac{C_2 \phi (1 - S_w)}{R.V.F.}$$

where: V_g = Volume of gas in million cubic feet per acre foot at 60° F. and pressure P_b contained in 1 acre-foot of bulk reservoir volume at pressure P_r and temperature T_r
V_o = Volume of stock tank oil in barrels per acre foot contained in 1 acre-foot of bulk reservoir volume
ϕ = Fractional rock porosity
S_L = Fractional liquid saturation
S_w = Interstitial water saturation
P_r = Reservoir pressure, pounds per square inch absolute
P_b = Gas measurement pressure base, psia
T_r = Reservoir temperature, °F., plus 460° F.
Z_r = Supercompressibility or gas deviation factor at reservoir pressure, P_r, and reservoir temperature, T_r
R.V.F. = Reservoir volume factor
C_1 = Constant for conversion to million cubic feet per acre foot at 60° F., equal to 22,651.2
C_2 = Constant for conversion to barrels per acre foot, equal to 7758

RESERVOIR ESTIMATES QUICK AND EASY



Calculating gas in place and recoverable gas . . .

EXAMPLE:
Porosity = 15%
Liquid Saturation = 20%
Reservoir Temperature = 175°
Supercompressibility Factor = 0.95
Pressure Base = 15.025 psia
Reservoir Pressure = 4150 psia

READ:
Gas in Place Originally = 1250 Mcf/a.f.

ESTIMATE:
Abandonment Pressure = 600 psia
Supercompressibility of Abandonment Pressure = 0.98

READ:
Gas in Place at Abandonment = 170 Mcf/a.f.
Recoverable Gas = 1250-170 = 1080 Mcf/a.f.

FIGURE 1

The use of the nomograph for calculating gas volumes (Figure 1) is as follows—(numbers refer to example shown on nomograph. All connecting lines are straight lines):

A—Connect rock porosity to reservoir temperature and determine point of intersection with diagonal line (1).

B—Connect (1) with liquid saturation and determine point of intersection with reference line "A" (2).

C—Connect (2) with supercompressibility factor and determine point of intersection with diagonal line (3).

D—Connect (3) to pressure base and determine point of intersection with reference line "B" (4).

E—Connect (4) with reservoir pressure and determine

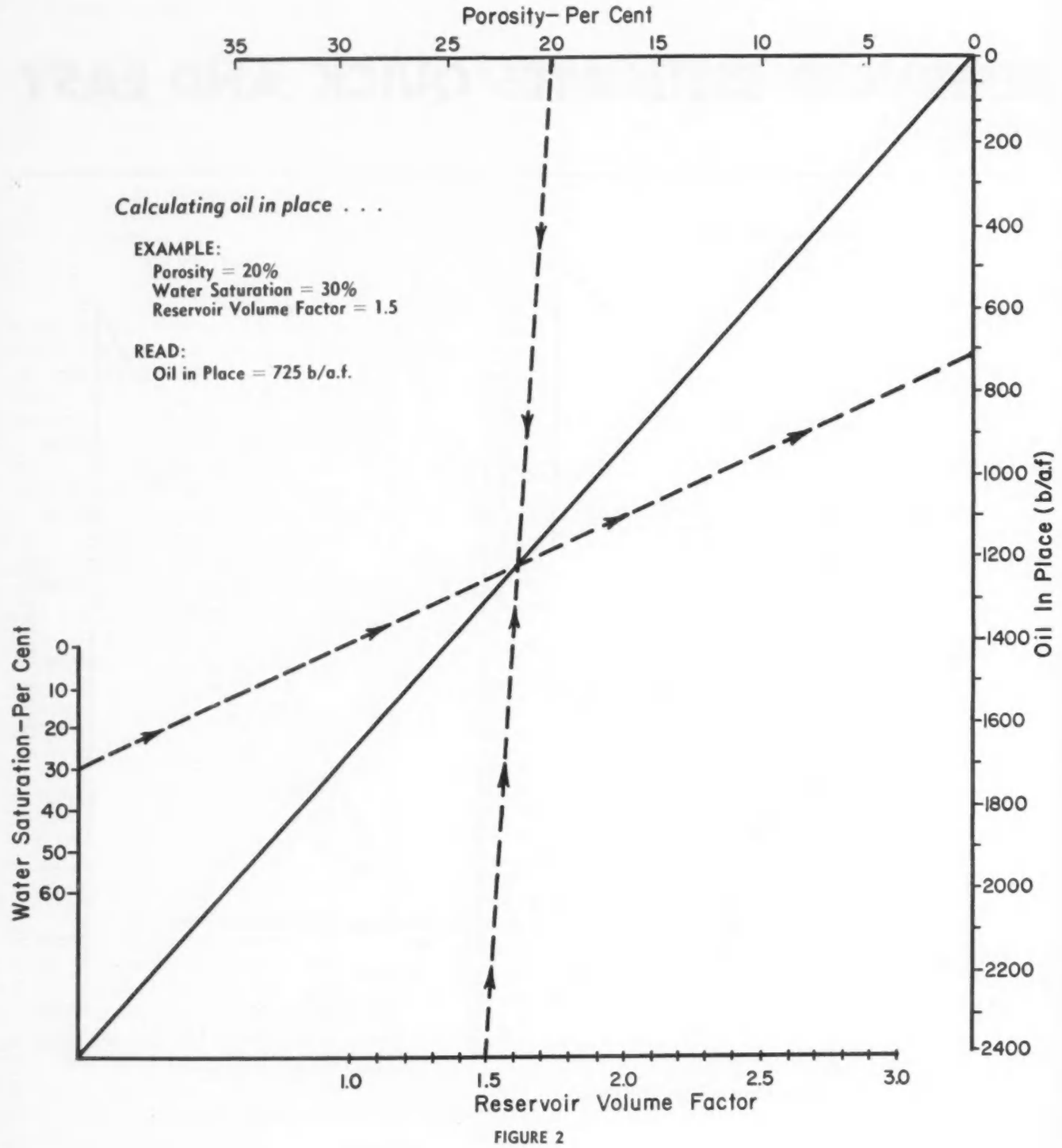


FIGURE 2

intersection with diagonal line which is the *gas in place* value desired.

If the reservoir under consideration is of the pressure depletion type, then this nomograph can be utilized for calculation of the recoverable gas reserves. This would entail an estimation of the abandonment pressure and a determination of the gas in place at abandonment. The difference between the gas either originally in place or at the time of the calculation and the gas in place at abandonment would represent the gas reserve. An example of this type is shown on the nomograph.

The use of the nomograph for calculating oil in place (Figure 2) is as follows:

A—Connect rock porosity to reservoir volume factor and determine point of intersection with diagonal line (1).

B—Connect (1) with interstitial water saturation and extend line to intersection of scale showing "oil in place." This value at the point of intersection is the calculated *oil in place*.

—**The End**

Long-Stroke Hydraulic Pumping Unit

Some of your pumping problems may be solved by these "gangling giants." What would you like to know about them?

1. **Does it compare with beam pumps?**
2. **What are the component parts?**
3. **How is it on shallow wells?**
4. **What about payout period?**
5. **What are the operating principles?**
6. **What are the advantages?**
7. **Do sucker rods suffer?**
8. **How are downhole pumps affected?**

By DOUGLAS M. JONES
Chief Engineer
Axelson Manufacturing Company
Los Angeles

THE QUESTIONS above are some of those posed by petroleum production people in their quest for more information on long-stroke hydraulic pumps. To fulfill these requests, here is a ready-reference on long-stroke hydraulic pumps with discussions on . . .

- Physical description
- Operational characteristics
- Advantages
- Pertinent engineering information.

Hydraulic Pump as a Machine. Figures 1, 2 and 3 illustrate some current models of this type of equipment. The variations used by different manufacturers extend to arrangement of components, the use of positive displacement pumps instead of centrifugal pumps and deadweight counterbalance instead of air; pressures and corresponding piston sizes of course vary. A variety of load ratings, cycle rates and stroke lengths are obtainable.

Figure 3a is the centrifugal pump operated unit with which the writer is most familiar and which will be described as a specific illustration of one of the several designs current. From this point on, where exact characteristics and specifications are noted, the discussion will refer to this centrifugal pump operated unit. General remarks will apply to the whole class of equipment.

In Figures 3a and 3b, major elements are:

1. A skid type frame including a pedestal for elevating the base of the cylinder stack
2. A prime mover
3. A V-belt transmission
4. A centrifugal pump
5. A large spherical oil and air pressurized reservoir
6. The cylinder stack some 30 feet or so in length, centered over the well
7. The necessary manifolding to transmit the operating fluid
8. Equally important but more difficult to identify are the reversing valve and the pilot valve which operates it.

A "scavenger" pump, air compressor, control valves, gages, filters, safety devices, etc., are essential elements of the machine, but cannot all be covered in this discussion.

In raising and lowering sucker rods a typical upstroke load might be 27,000 pounds, with the downstroke load 15,000 pounds. Thirty thousand pounds is maximum rated peak load, with a 14,000-pound load range.

The main power source runs continuously and rotates the centrifugal pump in one direction through a V-belt drive and countershaft.

On the upstroke, the air under pressure in the reservoir forces the oil into the centrifugal pump suction side with a net positive suction head of as much as 300 pounds per square inch. The pump adds the "boost" necessary to overcome losses and provide the required thrust under the piston to raise it against the upstroke

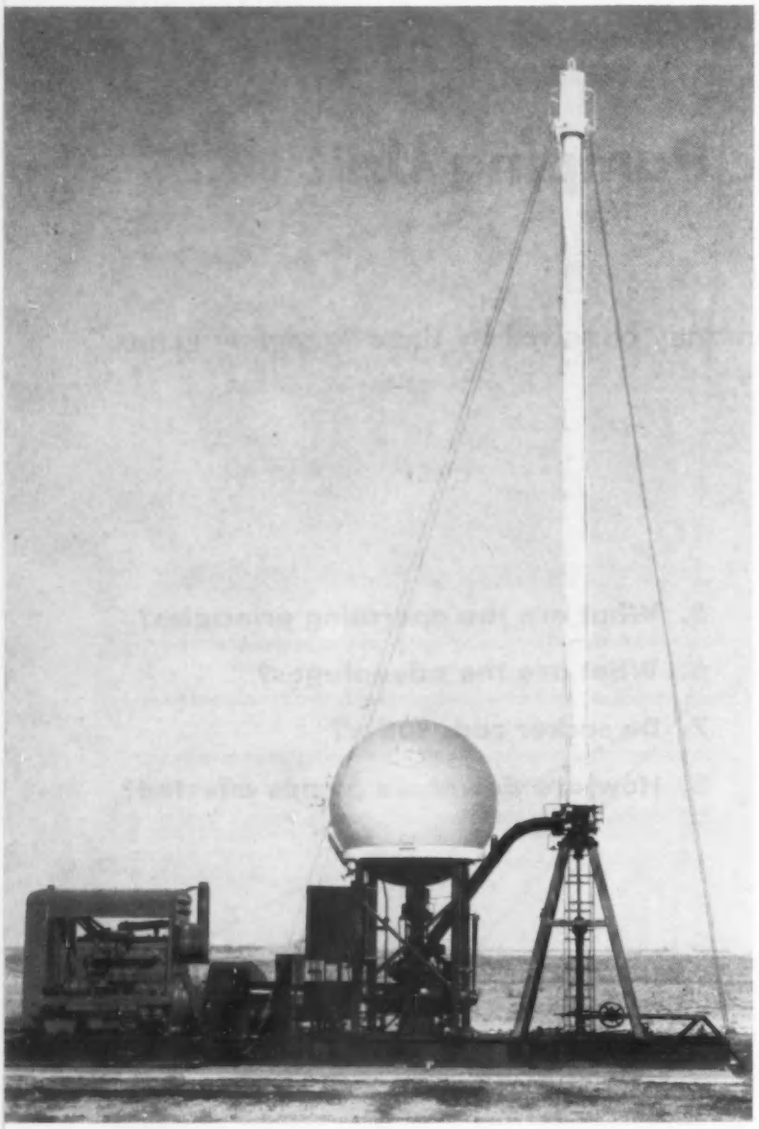


FIGURE 2—An illustration of a current model of the hydraulic pumping unit, showing one of the variations of equipment installations which still retains the inherent advantages of this type of unit.

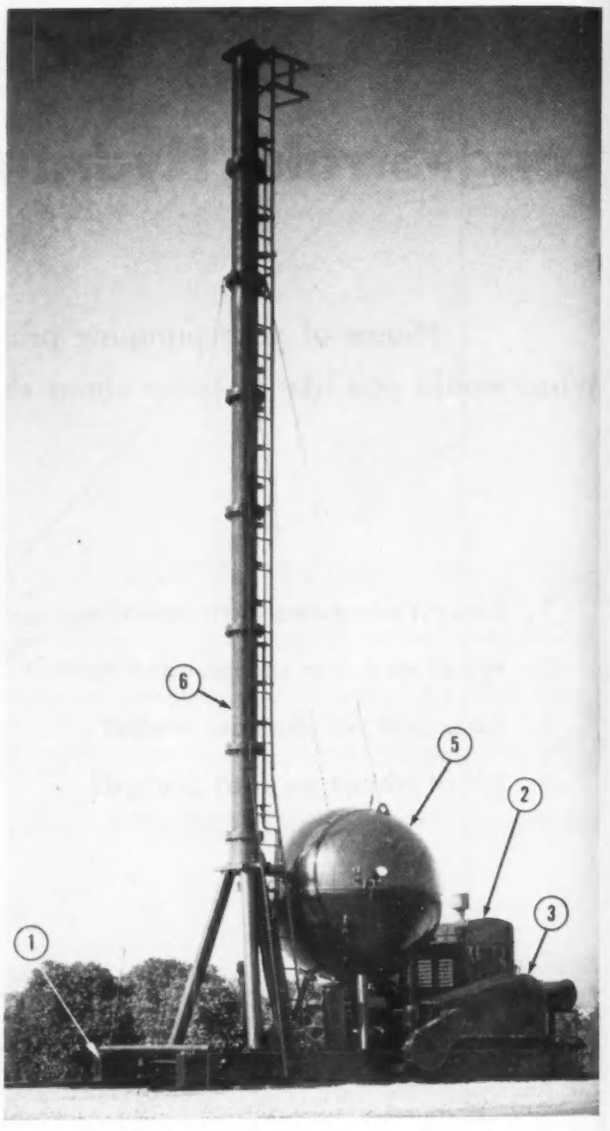


FIGURE 3a—The centrifugal pump-operated unit. 1—Skid-type frame; 2—prime mover; 3—V-belt transmission; 5—Spherical reservoir, and 6—Cylinder stack. (Figure 3b on Page 159)

load. At the end of the upstroke, a port is uncovered to actuate a pilot valve and thence the reverse valve. This supercharges the pump suction with pressure furnished by the falling weight of rods in the well on the downstroke. The pump furnishes the boost required to return its discharge, now routed through the manifold, into the reservoir compressing the air and re-energizing it for its job of assisting the pump on the upstroke. Thus the air is a counterbalance which permits a fairly uniform power demand over the complete cycle.

The centrifugal pump is the heart of the unit. It has a very heavy volute case, mechanical shaft seals, anti-friction bearings and a dynamically balanced impeller. With a recommended maximum revolutions per minute of 2200, it has a capacity of more than 1600 gallons per minute and boost of over 130 psi.

Figure 4 shows portions of selected characteristic curves of head vs. capacity for two different impellers. One typical curve of power input to the pump vs. capacity is also shown. (Horsepower scale not given, has values increasing upward.)

Say for example that the average desired cycle rate of the subsurface pump for a given installation is such that 1400 gallons per minute average discharge rate is needed at the centrifugal pump. Also from the well loads and estimated losses, etc., it is determined that the average boost required is 100 psi. These factors as co-ordinates fall on the 2000 revolutions per minute curve for the impeller, and the corresponding power to operate the centrifugal pump would be calculated, or read from the 2000 rpm power curve at 1400 gpm. The prime mover, assumed here to be an internal combustion engine, would have a throttle setting to supply a horsepower somewhat greater, at a certain speed.

During one complete cycle of the sucker rods and subsurface pumps, there are two points where the re-

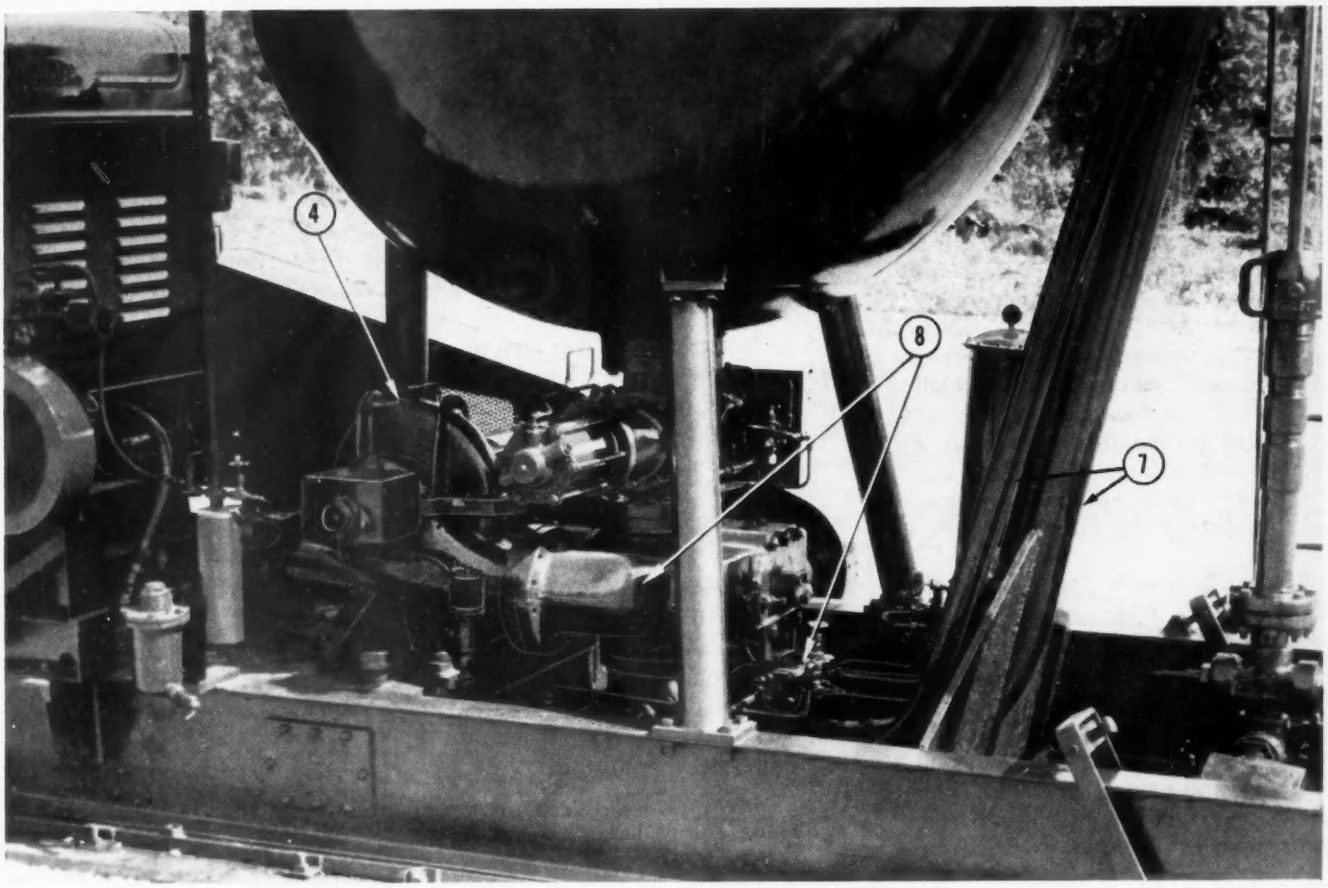


FIGURE 3b—Close-up of some of the major elements of the centrifugal pump-operated unit. Shown are: 4—centrifugal pump; 7—manifold, and 8—pilot and reverse valve.

quired pump boost increases to a maximum. This is due to the fact that the air counterbalance expands, dropping the supercharging pressure (net positive suction head) through a total range of about one tenth of maximum pressure. The well load, however, is relatively constant on the upstroke at one value, and on the downstroke at another. In consequence, the centrifugal pump is called upon to make up the difference of about 10-15 psi upward from *average* twice in a cycle, and has the same 10-15 psi more help than average twice in a cycle.

The centrifugal pump, as seen from the curves, has the interesting characteristic of loading itself in discharge when the load in head is released. For example, in the case we are considering, say the "load" in terms of required pump boost decreases twice per cycle to 88 psi. Each time this occurs, a series of events follows in which:

a. The operation of the pump tends to "slide" down the 2000 rpm characteristic.

b. The volume discharge increases.

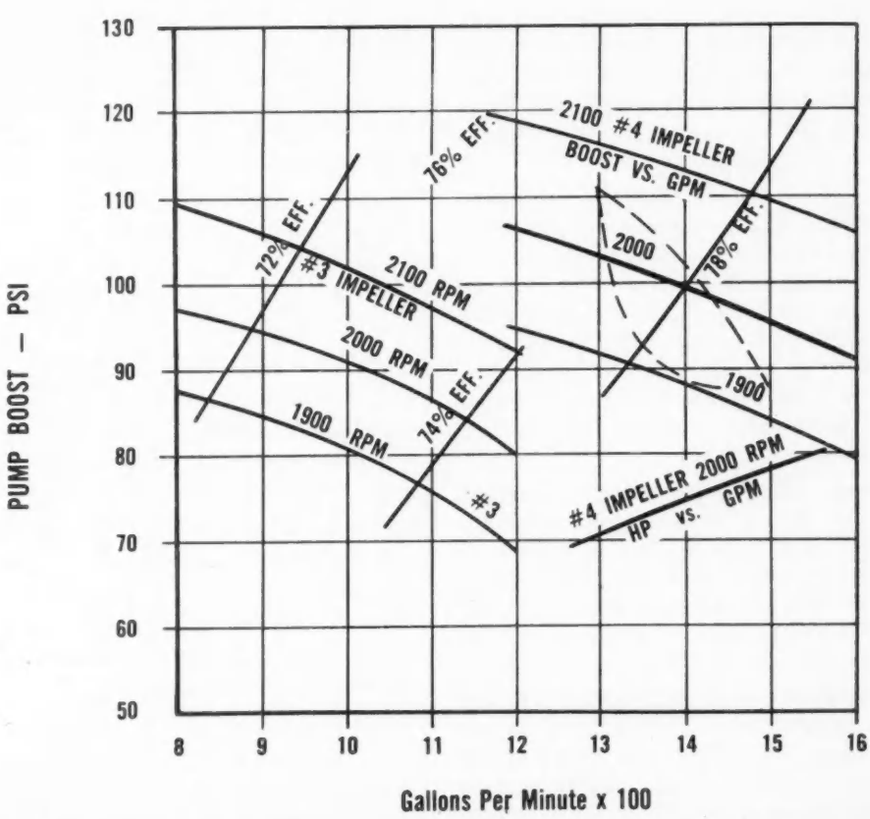


FIGURE 4—A portion of selector characteristic curves of head vs. capacity for two different impellers.

c. The brake horsepower demand increases with increased volume, increasing required input torque.

d. The engine, which at a given throttle setting, tries to maintain a constant horsepower output, drops off in speed due to the greater torque demand. (The event takes place too fast for ordinary engine governor action.)

e. The centrifugal pump in consequence drops off in speed, which assists in accommodating the impeller to the decreased boost without a large increase in discharge rate and consequent speeding of the piston.

The cycle is such that the fall-off occurs rapidly, while the build-up of boost is gradual, over a full half cycle. The general train of events during build-up however is similar, except that as boost demand *increases,* discharge rate *decreases,* bhp demand *decreases* and engine speeds up. This allows increased pump boost from faster impeller speed as well as from decreased discharge.

The instantaneous operation would follow a trace on the curves somewhat as shown on Figure 4 by the dotted line, and the loop occurs twice during the well pumping cycle. It will be seen from the above described action that it is not desired to have too close engine speed regulation, since a speed variation assists rather than hampers smooth operating.

Included in the pumping unit considered as a machine, are many other elements nearly as interesting as this centrifugal "heart": the detail of the counterbalance cycle, the pilot valve and reverse valve system, the vacuum cycle in the air over the piston, the safety devices for shut down in case of rod break, the filter system, etc.

Hydraulic Pumper as a Production Tool. For a given subsurface pump bore and fluid gravity, the fluid load varies with hydrostatic pressure and therefore as the depth of pump setting if the fluid is lifted all the way. It is the range of fluid load over the pumping cycle which imposes an elongation stroke loss or difference between surface rod stroke and subsurface plunger stroke. This loss limits production of oil.

Assuming a given rod size, pump bore and fluid gravity, and with fluid lift equal to pump depth, the stretch loss varies as the *square* of the depth, jumping from, say 2 feet at 3000 feet to 8 feet at 6000 feet. This is because total elongation is the product of length of string and load, each of which are proportional to depth. Relatively few mechanical pumping units have stroke lengths of 8 feet to begin with.

Various factors modify this picture. To name a few briefly: For faster pumping speeds, subsurface amplitude tends to increase due to vibratory motion. In trade parlance, this effect is usually called "overtravel." It adds to subsurface stroke but also to rod stress.

Another factor alleviating stroke loss is the fact that the deeper pumping wells do not tend to produce volumes requiring the larger pumps. Also, the rod strings are heavier due to imposed rod, impulse and fluid loads, and hence stretch less.

These factors notwithstanding, loss of stroke became a serious problem with increased depth, and the logical answer to a large loss was a longer surface stroke. Walking beam pumping units were designed with available stroke length to 10 feet and a very few to 12 feet. (Recently a few 16-foot stroke beam units have been built.) The tremendous size and moving mass of these units made it appear that about 10 feet was a reasonable limit. However, the simplicity and reliability of sucker rod pumping were sufficiently advantageous to create a strong demand for a long stroke rod actuating unit to meet the depth challenge; and the hydraulic long stroke units provided the answer.

After the first of these units were in the field a very few years, two somewhat unexpected results in their use became apparent. One was that some of the most spectacular "payouts" were in relatively shallow, large production wells as opposed to the deep ones the units were designed for. Another was that surprisingly high rod stresses could be used satisfactorily with the hydraulic units.

The spectacular shallow payouts came about in such installations as the following case history of a well pumping from 3400 feet with a 2¾-inch bore pump. The combination of added production, about 440 barrels per day of fluid, or 35 barrels per day of oil, and elimination of rod jobs after installing a long stroke hydraulic unit combined to total about $3000 per month increased earnings plus savings.

The usual story in such installations is that production alone could be increased with the beam unit by increasing pump size and cycle rate. However, the resultant stress would part rods disastrously. A like situation holds in the deep wells where the vibratory "overtravel" may theoretically be increased by increasing cycle rate until stretch loss is entirely overcome by increased subsurface amplitude. However, in most wells, this motion is entirely incompatible with economical sucker rod life.

Some of the mechanics of long stroke advantage in sucker rod life are obvious, and some can be explained, while some factors have not been satisfactorily rationalized to date. On the obvious side is the fact that if the commonly used Simple Harmonic Motion acceleration factor be assumed to reasonably represent the impulse factor applied to rod weight and adding to rod stress, then this impulse varies directly as stroke length but as the square of cycle rate. For a given rod weight and subsurface pump average plunger velocity, a shorter stroke must thus build up the impulse factor in three ways: one, cycle rate must be increased to maintain surface velocity; two, the surface stroke is less effective at the pump due to nearly constant stroke loss in inches per stroke (this means even faster stroking to maintain subsurface velocity); three, the doubly increased cycle rate affects the impulse factor as the square.

In addition to increasing peak load of the cycle, a high impulse factor tends to decrease minimum load and thus to have a double effect on load range. To appreciate this effect of both increasing maximum stress and load range, a brief look should be given the loading, allowable stresses and character of rod breaks: Sucker rods almost always fail in fatigue, the break showing little or no necking down. Study of a broken end discloses that a surface nucleus (usually a corrosion pit but sometimes other-

wise) forms the apex of a relatively smooth area beat down by repeated working. A fibrous appearance characterizes a second small section which represents final failure in tension.

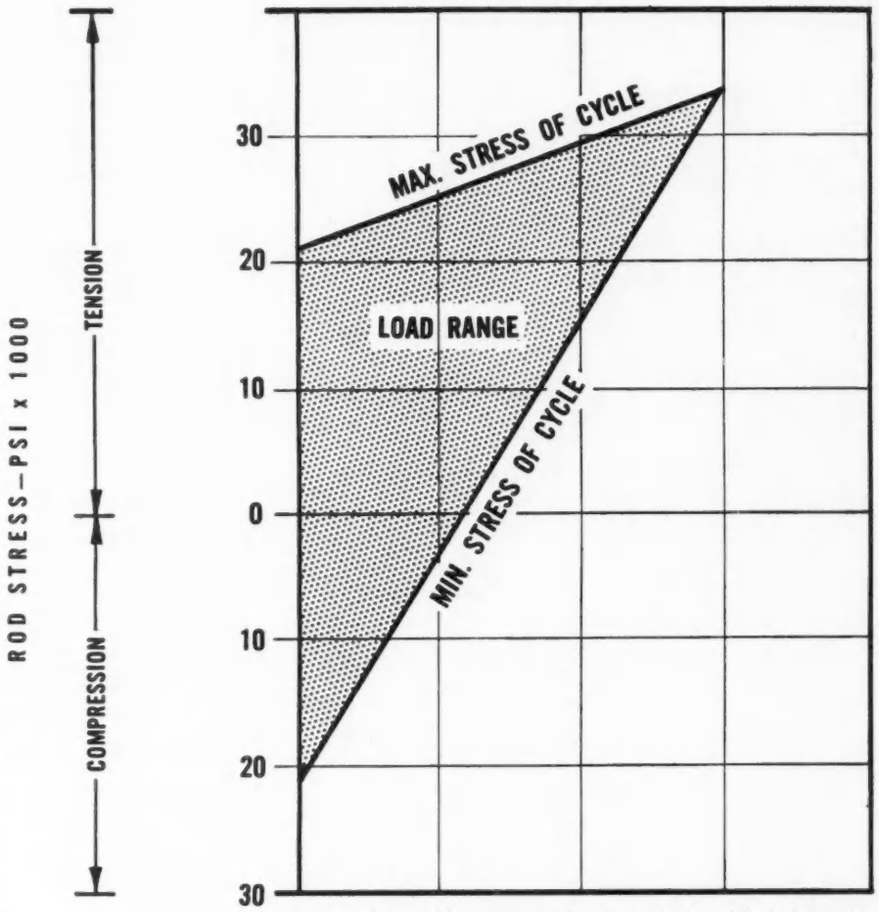
Having established that failure is in fatigue, the nature of loading becomes important. A few rods near the pump have a compressive column load during part of the downstroke, but the upper more highly stressed rods have a positive (tensile) minimum stress upon which is superimposed a varying additional tensile load. It is a well accepted engineering principle that in such a varying load cycle, the severity of service increases with stress range in relation to maximum stress. This may be depicted on a classic early Goodman diagram or as represented in Figure 5 by a more modern version. This chart is based on construction suggested by Kommers[1] and adapted to high grade rods in good condition by one manufacturer for environment not seriously corrosive.

Those familiar with pumping field practice recognize the chart peak stresses as being reasonably comparable with values in common use, although it is not customary to see the stress range relation represented. To engineers in other fields, it may come as a shock to see such low stresses used in an era when 260,000-psi steels are widely used in aircraft. The shock is even greater when it is learned that sucker rod stress is the critical limiting factor in many hundreds of installations. The industry is apparently behind the times.

However the appearance, the fact is that sucker rod manufacturers spend many thousands yearly in research to improve useability of higher strength through metallurgy, processing, treatment and finish. They have had, however, little success in using steels of tensile strength over 110 or possibly 125,000 psi, while a premium low alloy rod now and for many years a standard of quality has only 85,000 to 90,000 psi tensile strength. (It is felt by many that with careful handling in a noncorrosive well, generally higher stresses might be satisfactory.)

The reasons for limitation of tensile strength in successful rod pumping are several; chief among them are:

1. Since failure is through fatigue, surface finish is critical.



Courtesy Axelson Manufacturing Company, Division of U. S. Industries.

FIGURE 5—Stress range diagram for sucker rods.

2. The combination of mechanical damage through handling, plus notching due to corrosion pits has so far made it impractical to preserve a very smooth and perhaps otherwise special finish which in itself would promote high fatigue strength of the rods.
3. The higher carbon steels usually used for higher strength seem, even despite alloying, more susceptible to corrosion pitting than their lower carbon brothers.
4. With fatigue nuclei as apparently a foregone conclusion, the greater notch sensitivity of the harder steels comes into evidence and as experience has shown, these stronger steels, above about 125,000 psi have generally failed to improve service or withstand higher loads.

Into this picture stepped a gangling giant designed to overcome stroke loss in deep wells. He did this job, but also proved to handle rods like babies. Working rod stresses were increased 10, 20, then 30 percent, still with increased rod life. Again, where the big units were put on high production, shallower wells, characterized by high stress range and consequent rod breakage, it was found that the load range apparently had lost its

About the Author

DOUGLAS M. JONES obtained his BSME degree at the University of California in 1930 and went to the E. M. Smith Company in Los Angeles for six years. In 1936 he joined the Engineering department of Axelson Manufacturing Company where he is now chief of that group. A registered engineer in California, he is a member of the API, the National Society of Professional Engineers and the ASME. Jones has authored considerable work in mechanical engineering of production equipment.

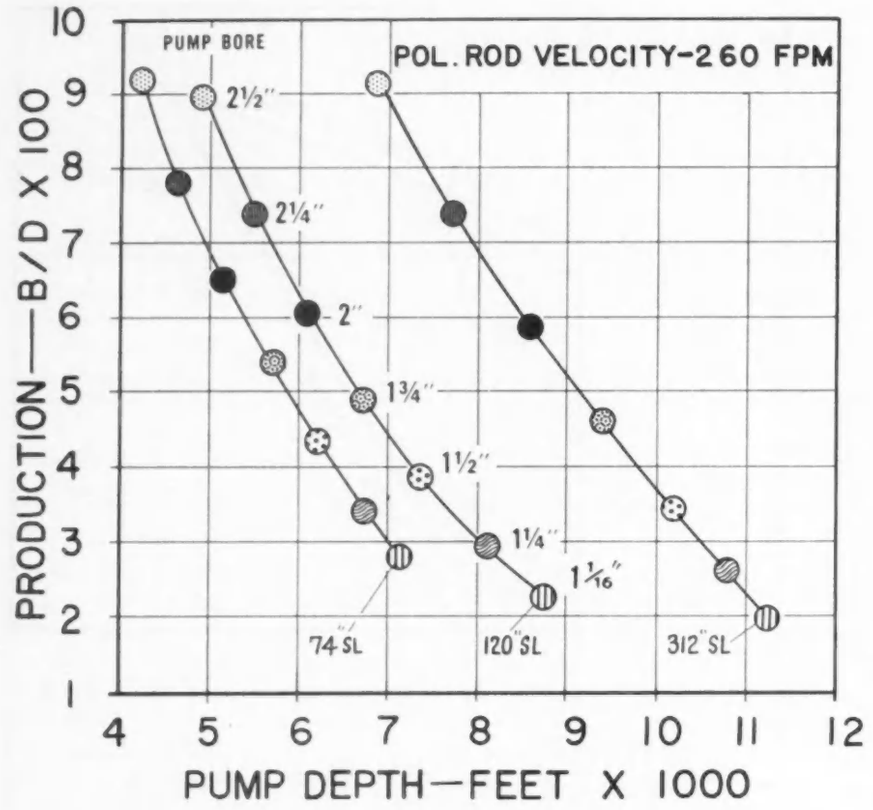


FIGURE 6a—A comparison of beam and hydraulic long stroke pump performance.

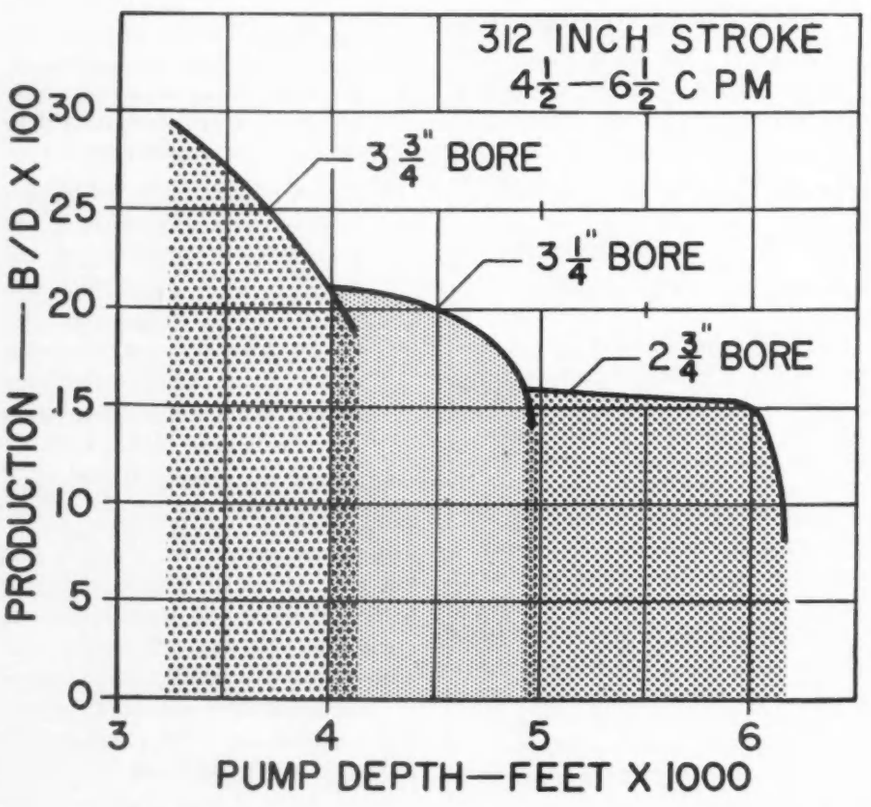


FIGURE 6b—Production for large bore pumps available with the long stroke unit.

threat. In fact, even highly loaded installations which had been parting rods regularly through corrosion fatigue settled to good behavior with the big hydraulic units, with generally increased production.

Engineers tried to shrug off the early spectacular rod life with such expressions as "At five cycles per minute, it just takes longer to reach the eventual life in cycles." This was disproved as hydraulic unit installations were made with the old fatigued rods that had been breaking left in the well, and still rod failures were practically eliminated.

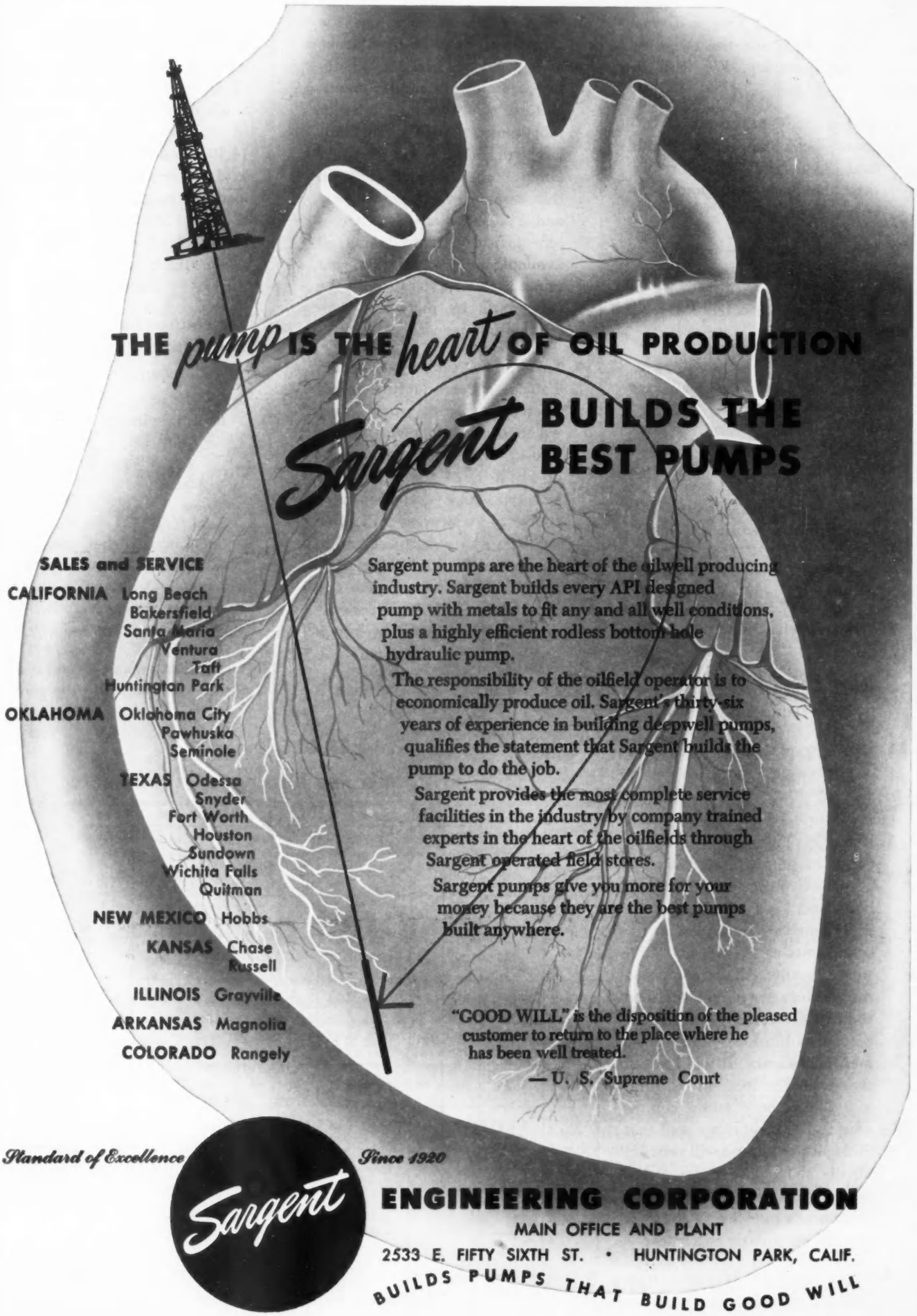
It has been conjectured that the rigidity of a heavy steel walking beam unit may contribute to high stress peaks in the rods beyond those measurable with ordinary polished rod dynamometers. Some evidence taken with resistance strain gauges and oscillograph has been offered to support this theory. The author has a theory which frankly has had few supporters. This is that the relatively long periods of almost steady load on upstroke and downstroke together with the low cycle rate of the long-stroke hydraulic unit combine to change the degree to which the loading partakes of the nature of fatigue. Evidence is here to support it; testing at 10-12 second period to refute or support it is certainly rare.

Figure 6a provides a means of comparing beam and hydraulic long stroke performance. The depth limitations are such that top one-inch rod stresses are within usual limits for beam pumping and peak loads are held to 30,000 pounds for the hydraulic unit. Figure 6b shows production for the large bore pumps available with the long stroke unit at from 4½ to 6½ cycles per minute.

In the discussion of sucker rod failures, the great success of modern inhibitors must be acknowledged. Together, the use of inhibitors and the big long stroke pumpers are writing a new book on sucker rod pumping.

Engineering an Installation. To illustrate installation engineering, an example is given. This solution is necessarily shortened but roughly illustrates steps required to obtain the essential information.

• **The Problem:** It is desired to pump 600 barrels per day lifting 10 API



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Sargent pumps are the heart of the oilwell producing industry. Sargent builds every API designed pump with metals to fit any and all well conditions, plus a highly efficient rodless bottom hole hydraulic pump.

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fluid from 7500 feet. This is a very heavy job and outside the range of conventional pumping. We wish to know:

1. Will a unit rated at 30,000 pounds peak load, 14,000 pounds load range and 26-foot stroke take the loads and pump the volume?
2. What subsurface pump bore should be used?
3. What cycle rate is required?
4. What sucker rod string?
5. What chief cylinder loads are imposed?
6. What counterbalance pressure should be used?
7. What centrifugal pump discharge rate is required?
8. What centrifugal pump boost is required?
9. What impeller and rpm are required?
10. What prime mover brake horsepower is required?
11. Recommend size of engine by displacement.

• **Solution:**

1. Refer to Figure 6a showing depth to pump plotted against production for several pump bores and for a long stroke unit at 312-inch stroke as well as for beam units at 74-inch and 120-stroke lengths. All are computed for 260 feet per minute polished rod average velocity and for 100 percent subsurface pump volumetric efficiency. It will be seen that with the long stroke unit, a 2¼-inch bore pump can be used to 7800 feet depth and that 260 feet per minute will produce about 730 barrels per day at 100 percent volumetric efficiency, or 600 barrels per day at about 82 percent volumetric efficiency.
2. From above, the required pump bore is 2¼ inches.
3. 260 feet per minute sets the cycle rate for a 26-foot stroke at 5 cycles per minute. Therefore, from this or similar manufacturer's performance index or table plus production calculator if required, a cycle rate and pump bore are determined: in this case 5 cycles per minute and 2¼-inch bore. If there is any difficulty in producing all available fluid at 5 cycles per minute, the cycle rate may be increased by increasing centrifugal pump speed.
4. To obtain a sucker rod string, Table 1 is reproduced here for reference. For 2¼-inch bore, we find the following data: Gross fluid load per foot of lift is 1.724 for 1.0 specific gravity, which corresponds of course to 10 degrees API. One inch top rods were presumed in Figure 6 so we find 31 percent–1 inch, 35 percent–⅞ inch and 34 percent–¾ inch recommended. The average weight is noted as 2.18 pounds per foot.
5. The steady downstroke load is very closely the weight of rods in fluid. In 10-degree fluid, this is 0.873 times the weight in air. (In general, the factor is 1-0.127 S where S is specific gravity.) $M = 0.873\ (7500)\ (2.18) = 14{,}300$ pounds downstroke. The load range is closely the fluid load on the gross plunger area, or $R = 7500\ (1.724) = 13{,}000$ pounds load range. The upstroke steady load is the sum of $M + R = 27{,}300$ pounds.
6. The counterbalance pressure should have a mean value of $M + \frac{R}{2}$ pounds converted to psi by the net area of the piston = 81 square inches.

$$C = \frac{1}{81}\left(M + \frac{R}{2}\right) \qquad (1)$$

$= 257$ psi

As mentioned earlier, the variation in counterbalance pressure will be about 5 percent up and down over the cycle so 270 psi maximum would be required.

7. The discharge rate corresponds to the area swept by the piston

TABLE I

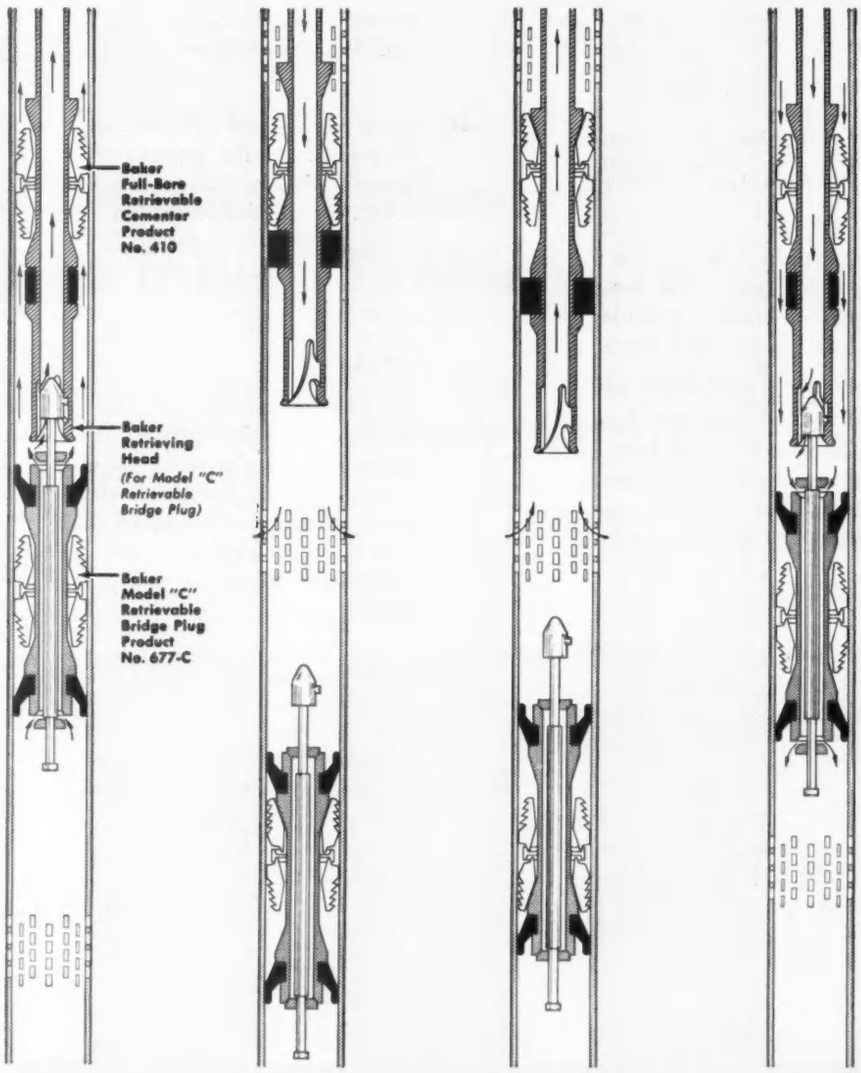
ROD AND FLUID DATA

Pump Bore	Wog/h' Gr. Fl. Ld. #/Ft. for SPGR=1.0	⅞" & ¾" ROD STRING			1", ⅞" & ¾" ROD STRING					
		% ⅞	% ¾	Ave. #/Ft.	% 1	% ⅞	% ¾	W_R/h Ave. #/Ft.	Stretches Like % ⅞	Stretches Like % ¾
1-1/16	.384	23	77	1.745	18	20	62	1.95	50	50
1¼	532	25	75	1.755	19	22	59	1.98	55	45
1½	766	29	71	1.780	22	24	54	2.02	60	40
1¾	1.043	33	67	1.800	24	27	49	2.06	65	35
2	1.362	37	63	1.820	27	30	43	2.11	75	25
2¼	1.724	42	58	1.850	31	35	34	2.18	85	15
2½	2.128	47	53	1.875	35	40	25	2.26	100	0
2¾	2.575	53	47	1.900	39	44	17	2.33	10%1"	90%⅞
3¼	3.596				47	53	0	2.48	47	53
3¾	4.790				57	43	0	2.55	57	43

courtesy Axelson Mfg. Co. DIVISION OF U.S. INDUSTRIES

TYPICAL OPERATION

Product No. 410


Baker Full-Bore Retrievable Cementer Product No. 410
Baker Retrieving Head (For Model "C" Retrievable Bridge Plug)
Baker Model "C" Retrievable Bridge Plug Product No. 677-C

RUNNING-IN
Retrievable Bridge Plug being run into well on bottom of Full-Bore Cementer through use of Retrieving Head. Note fluid by-pass.

FRACTURING OR ACIDIZING
Plug should be pressure tested after release. Cementer is released, raised above perforations and reset for pressure operations.

SWABBING, TESTING
Note how the reversal of pressure differential has transferred load from one set of slips to the other (both cementer and plug).

RETRIEVING
Plug and Cementer being moved to next set of perforations—or retrieved from well. Valves in plug open to permit fluid by-pass.

BAKER FULL-BORE RETRIEVABLE CEMENTER

HOLDS PRESSURE FROM EITHER ABOVE OR BELOW

Two sets of opposed slips enable the cementer to hold pressure from either above or below. Casing can be tested before squeeze—and the tubing also, if the Baker Full-Bore Tubing Tester is used.

FULL BORE CONSTRUCTION

Permits Passage of Tubing Perforators or Instruments—Assists in Preventing "Screen-Out" on Fracturing Jobs

The Full Bore through the Cementer (and Tester if used) is in reality a continuation of the bore through the tubing.

This continuous full ID passage not only permits passage of tubing perforators or instruments but assists in preventing "Screen-Out" (sand dropping out of the oil) and subsequent plugging of the tubing in fracturing jobs.

IDEAL STRADDLE TOOL WHEN USED WITH BAKER RETRIEVABLE BRIDGE PLUG

The operation of the Cementer setting mechanism makes it easy (through the use of the Retrievable Bridge Plug Retrieving Head) to release and pick-up the Baker Retrievable Bridge Plug. It is in fact the ideal partner to the Retrievable Bridge Plug for selective multiple-zone or single-zone operations.

these products and their application

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during the time for one upward stroke.

$$G = 0.7\,LN \qquad (2)$$

where L = inches stroke length
N = cycles per minute
= 0.7(312)(5) = 1090 gpm

8. Average pump boost is average cylinder boost plus losses. The cylinder boost is cylinder range divided by two times piston area, or $\frac{R}{162}$ = 81 psi closely. Fluid volumetric losses and friction losses have been lumped as an equivalent pressure loss for convenience and may be expressed as approximately

$$P_L = 0.14\left(\frac{G}{100}\right)^2 \qquad (3)$$

in this case for G = 1090 gpm
P_L = 16.6 psi
and average pump boost is
$P_B = 81 + 16.6 = 98$ psi closely

9. The "characteristic" head vs. gpm curves for the pump may be entered with this boost and discharge rate to find 2100 rpm closely required for a "No. 3" impeller. (See Figure 4.)

10. Pump mechanical efficiency may be noted from the pump curves also as 73 percent for this impeller. By standard formula, the input power to the pump is:

$$H_i = \frac{GP_B}{1715\,(0.73)} \qquad (4)$$

= 85 hp

To provide adequately for a margin in engine performance below new engine curves, plus V-belt drive and counter shaft losses, a realistic 85 percent efficiency from engine curve to centrifugal pump is used, resulting in:

$$\text{Engine bhp} = \frac{85}{0.85} = 100 \text{ hp}$$

11. Considering a modern multicylinder natural gas engine, 1100 rpm is a preferred speed in many fields for certain types and 60-67 brake mean effective pressure a preferred loading.

$$BMEP = \frac{(hp)\,(792{,}000)}{(rpm)\,(displacement)} \qquad (5)$$

From which we find a desired displacement = approximately 1070 to 1200 cubic inches.

In considering this large horsepower and engine size, it must be recalled that we intentionally chose a big job, lifting 600 barrels per day from 7500 feet with casing fluid level at the pump. In comparison, similar units are lifting 100 barrels per day or so from 10,000 feet and require only about 35 hp.!

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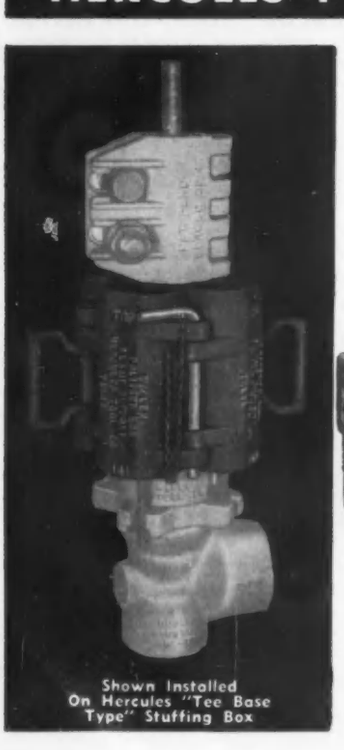
ACKNOWLEDGMENTS

The author is indebted to the following for information on long stroke hydraulic pumping units: Axelson Manufacturing Company, Division of U. S. Industries, Inc., Los Angeles; Lufkin Foundry & Machine Company, Lufkin, Texas; Oil Well Supply Company, Division of U. S. Steel, Dallas; Pelton Water Wheel Company, Los Angeles, and Vickers Corporation, El Segundo Division, El Segundo, Calif. Thanks are extended to all who assisted in gathering and preparing material and to the management of the author's firm for support of the project and permission to use excerpts from proprietary literature.

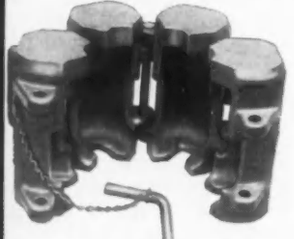
Prevent Damage to Packing and other Component Parts with a

HERCULES POLISHED ROD CLAMP-OFF SUPPORT



Shown Installed On Hercules "Tee Base Type" Stuffing Box

Developed to prevent damage to the packing and other component parts of Hercules Stuffing Boxes while "clamping-off." Transmits weight of rods to tubing by resting upon top of the Stuffing Box body. Fits all types Hercules Duplex Stuffing Boxes. Made up of four sections hinged together, making it easy to install around Stuffing Box and is locked by means of a latch pin. Handles are provided to facilitate handling. Constructed of high grade malleable iron. Will accommodate all size polished rods and liners up to and including 1¾". Will safely support the longest string of rods.



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Help—not a handout . . .

U. S. Oil Industry Called Answer to Indian Problem

Despite an unfavorable petroleum law, author says India and its potential could be weaned away from the Russians and ultimately made available to private capital from abroad in its search for new crude reserves.

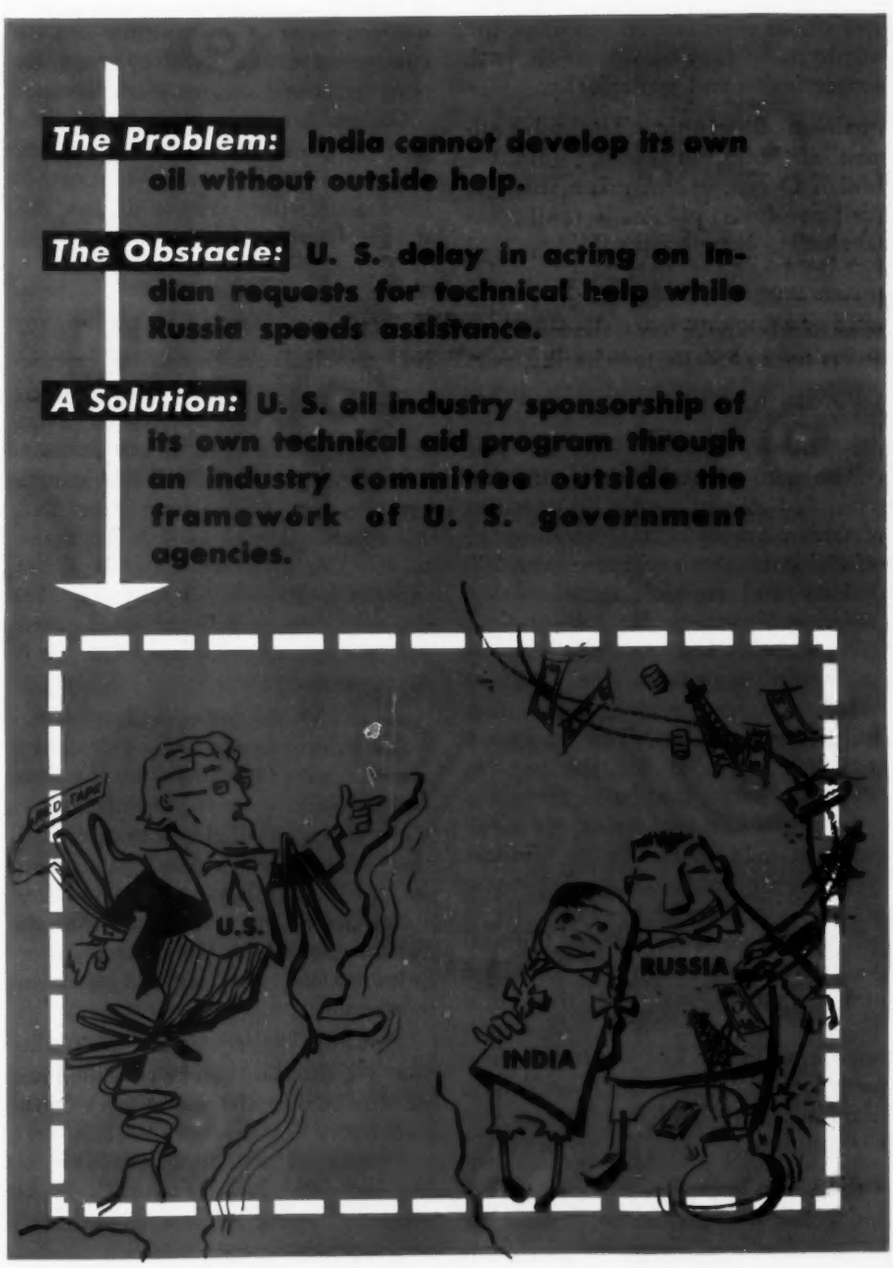
By HENRY CARTER REA
Petroleum Consultant
Denver

THE SEARCH for new oil reserves throughout the Free World by U. S. operators is becoming more intense each year as the cost of finding new replacements in the U. S. continues to rise. The situation has forced the U. S. operator to look abroad to find some country where political and economic climates are simultaneously favorable for his operations.

The problem of satisfying the mounting world demand for petroleum and its products has been placed directly upon the shoulders of the exploration geologist. It has forced him, along with his many other duties, to become a politico-economist. Because of present-day resurgence of the nationalistic spirit in many countries of the free world, generally sponsored and abetted by Communists, possibilities of developing new oil reserves abroad are unfortunately limited—not by geological considerations but by man-made dictates of the political climate he has created.

It would appear that the example set by the U. S. oil industry in developing the world's oil resources would be sufficient evidence that the free-enterprise system is so far the best that has been developed. Too, it would appear that countries with potential oil resources could draw upon this rich reservoir of practical experience in formulating their exploration and development laws and programs.

But such is not the case. Through fear, ignorance and selfishness guided by the heavy hand of bureaucracy and furthered by the shouts of na-


The Problem: India cannot develop its own oil without outside help.
The Obstacle: U. S. delay in acting on Indian requests for technical help while Russia speeds assistance.
A Solution: U. S. oil industry sponsorship of its own technical aid program through an industry committee outside the framework of U. S. government agencies.
U.S.
RED TAPE
INDIA
RUSSIA

tionalists that the nation's oil belongs to its nationals, many countries have more than succeeded in keeping their oil—in the ground!

Two years ago Pakistan adopted a petroleum law favorable to the free enterprise system. The law immediately produced results with the entrance of both international oil companies and independent operators. Exploration work now is well under way, and it would be geologically safe to say that Pakistan will join, in the not too distant future, the ranks of the larger petroleum producing nations of the world.

Being somewhat familiar with the regional geology of India and Pakistan, it was only natural to look across the border at India, whose adjacent geological conditions were not effected by a political boundary and whose potential oil resources are worthy of serious consideration, both economically and geologically.

Position Strategic. The subcontinent of India, jutting out into the Indian Ocean, commands a strategic position—both politically and economically—between the Middle East and the Far East. Its 1.2-million plus square miles of deserts, plains, mountains, and jungles give the nation a diversity of climate, topography, people, and natural resources that is exceeded only by Russia and China on the continent of Asia.

The monumental task of unifying some 380 million people (85 percent of whom are illiterate), speaking 14 official languages and more than 200 dialects and recognizing all of the major religions with all of their splinter sects has demanded strong leadership in government and, of necessity, a veering towards socialism and the welfare state. This leadership is being provided by the present prime minister, Jawaharal Nehru.

It can be said that today, the Government of India and Prime Minister Nehru are synonymous, and, because of the high esteem in which he is held by the great majority of Indians, his powers—constitutional, implied and arrogated—approach that of a dictator. However, there is a strong opposition in the Lok Sahba (Parliament) that is extremely vociferous upon occasion—and they are not the Communists.

Relies on Imports. The fact that India imports about 95 percent of its petroleum requirements (135,000-plus barrels per day) mostly from the Middle East and Indonesia and produces only 7000 barrels a day is sufficient reason to investigate the politico-economic climate of this, or any other country that has petroleum possibilities. The bulk of India's oil consumption is in the more heavily populated and industrialized areas of the south where transportation and refining centers offer no particular problem. This situation has had a direct economic influence on its policy of developing its own potential oil resources in the past.

Since the present tanker supply system has been able to maintain India's consumption needs, there was no economic reason why the country should attempt to develop its own resources. For its potentialities lies mostly in the northeast and northwestern parts of the country and development would involve heavy expenditures and serious transportation problems—not taking into consideration expenditures required to find and develop an oil field that would have a minimum reserve of, say, 500 million barrels to warrant an 800- to 1000-mile pipe line to markets.

Development Considered. Today, however, India, with an ever-expanding petroleum market and particularly with the emphasis to be placed on the expansion of heavy industry and the development of her natural resources in the Second Five Year Plan (1956-1961), now is beginning to consider more seriously the development of its own oil resources. The drain of about $100 million a year for oil imports could be put to better use in other fields.

As no definite policy with reference to the development of oil resources has yet been formulated by the Central Government, the future, as of the moment, is highly speculative. If the Central Government's past record in the field of nationalizing various industries is any criteria of what the future might hold for the free-enterprise system, the outlook is pessimistic.

However, there is the possibility that the situation can be remedied and influenced by active spade work on the part of the U. S. Government through its technical aid programs and by the judicious help of the U. S. oil industry acting in both an advisory and technical capacity.

Help From Russia. Under the present prime minister, India is committed to the philosophy of the welfare state, more out of necessity than by choice. The idea of the Central Government forming a company or agency to develop domestic oil resources stems strictly from a lack of knowledge of the entire situation. This idea has not been retarded by the reluctance of the U. S. in offering technical assistance after requests from the Government of India were politely refused because of differences in political ideology.

The USSR however, was not so deaf and immediately supplied a team (nine geologists and petroleum engineers) to explore the oil possibilities and to advise the Central Government on the requirements of technical personnel and equipment for a comprehensive program of oil prospecting. Provisions for this program have been made in India's Second Five-Year Plan. The Russian's final report has been submitted and is now under study by the Central Government. Too, another group of Soviet technicians combined forces with Indians to guide their geological exploration program in Rajasthan in western India.

The U. S. and the United Kingdom have been and are India's best customers. But there is a decided possibility that this position will change, by default on our part, due to the activities of Russia and its satellites. The Communists are continuing to offer assistance, both material and technical in all fields of endeavor. Also, many trade, friendship and cultural missions agreements and pacts have been made within the past few years.

It can be argued that the American way is the better way with reference to training, methods and equipment. But, and it is a big but, the cold facts of the matter are that the Soviet and its satellites already are on the ground and doing the job.

Need Is Recognized. One significant fact about India's investment climate is this: it recognizes the need for foreign capital and private investments. In addition, India is willing to offer terms of entry that would be attractive to foreign investors—except the oil industry in so far as exploration and development are concerned at present.

Refining, transportation and marketing of petroleum and its products, like the building of railroads, hospitals, steel mills, electric power plants, factories, dams, etc., are tangible objects. They can be seen, constructed and operated mechanically from blue prints, plans and instruction books. These things the Indian understands—for his investment he actually gets some physical property.

However, where investment involves risk capital through interpretations, ingenuity, know-how and other intangibles, as in petroleum exploration and development, the Indian is naive and inept because of his cultural, philosophical and religious heritage. He is optimistic and believes he can learn these intangibles from a book or by association with experienced and trained technicians. But, again, because of his heritage, he is probably the most reluctant individual in the world to make decisions and assume responsibility.

Petroleum Law. India has a petroleum law that, on the face of it, is bad. It was ill-conceived through ignorance of problems involved. Every possible hedge that could be thought of was incorporated in the law as protection against private capital from abroad. So much so that the nation protected itself out of business, and through both personal and national pride refused to request aid in this most vital subject.

This fact however, does not preclude the possibility of the U. S. oil industry offering its good services to the Indian government in the consultation and preparation of an equable petroleum law. The burden, it would seem, is on the U. S. oil industry. Mechanics of offering such a service will be suggested later.

Should War Come. It might come as a shock to the average American to consider our position in event of the neutralization of Middle Eastern oil fields (which supply Europe with about 75 percent of its oil needs) by atomic bombs. With Middle East oil fields out of the picture, Europe would be practically inert as an active ally. The U. S., Canada and Mexico combined could not oil another global war with their present resources.

Between 1942-1944, before gasoline was pipelined from the Assam fields to the forward areas in Burma, it was India's Digboi field that supplied gasoline for the Army and Air Force in Upper Assam. The Soviets are building a submarine fleet at the rate of 85 to 100 per year and that now numbers about 500 vessels ready for action (and Russia is not a maritime nation). Combine these factors with the vast, and the word vast is purposely used in all of its significance, potential oil reserves existing in the Aral-Caspian basin area of Central Asia, protected by the Himalaya mountain range on the south and the polar regions on the north, and it is obvious that neutralization of the Baku-Grozny fields of the Caspian sea area would have little effect in retarding any physical aggressive action by the Soviets for the lack of oil.

It is whistling in the dark to say that we, in turn, could neutralize those Central Asian oil fields for if we have a DEW (Delayed Early Warning radar system) line in Canada it must be assumed that the Soviets have something comparable across Siberia and Russia. When we say their transportation system is inadequate, how do we know? We forget that under their system of government a pipe line or railroad or other vital means of transportation can be ordered and the job done forthwith. Similarly, it would be foolish to say that their Central Asian oil fields have not been tested and that a long period of exploration and development would first have to take place before they would be in production. It can be assumed that these areas have been tested with the drill, potential production gaged and wells shut-in until a need arises.

U. S. Should Help. These facts and observations should be sufficient to point up the need of the U. S. in general and the oil industry in particular for taking the calculated risk of at least attempting to help India and other non-committed countries in:

- Formulating workable petroleum laws.
- Training their nationals in various specialities of petroleum exploration and development. Helping develop their resources.

It must be remembered that India is a democracy with a constitution which will compare favorably to that of the U. S. and Great Britain. Too, India's legal system is founded on the Anglo-Saxon principle of law the same as ours. The basic job of improving agricultural conditions to the extent that the country can be self-sufficient in food alone is a gigantic task and has shown a marked improvement in the past five years. We might condemn the welfare state and the socialistic way but, when 360 million people live on the borderline of starvation, those principles are as much justified as the measures taken in the U. S. during the days of the WPA to meet a national emergency.

It is apparent that the politico-economic climate of India today regarding the investment of U. S. capital for development of oil resources leaves much to be desired. At present India knows only one approach to this problem: that of the Soviet.

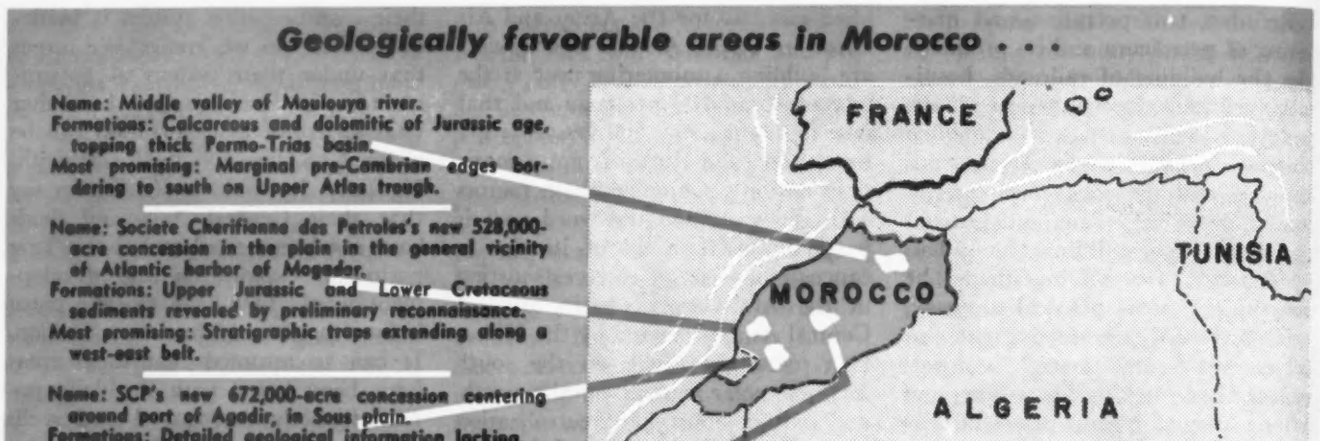
Prime Minister Nehru and his Minister of Natural Resources, K. D. Malaviya, have been to the Soviet Union and have seen Russian operations. It is with a feeling of assurance that progress in favor of the U. S.

Continued on Page 185

About the Author

AFTER GRADUATION from the University of California in 1927 in the geological sciences, Henry Carter Rea's assignments in exploration geology took him to almost every major oil province in North America, including Canada, and to Java, Borneo, India, Afghanistan, Pakistan, Baluchistan, Italy, and Holland.

For the past ten years, he has been an independent consulting geologist in the Rocky Mountain region specializing in the economics of petroleum geology and the politico-economics of foreign countries. His independent work in the Rocky Mountain region has accounted for five discoveries based on stratigraphic trap principles.


Geologically favorable areas in Morocco . . .
Name: Middle valley of Moulouya river.
Formations: Calcareous and dolomitic of Jurassic age, topping thick Permo-Trias basin.
Most promising: Marginal pre-Cambrian edges bordering to south on Upper Atlas trough.
Name: Societe Cherifienne des Petroles's new 528,000-acre concession in the plain in the general vicinity of Atlantic harbor of Mogador.
Formations: Upper Jurassic and Lower Cretaceous sediments revealed by preliminary reconnaissance.
Most promising: Stratigraphic traps extending along a west-east belt.
Name: SCP's new 672,000-acre concession centering around port of Agadir, in Sous plain.
Formations: Detailed geological information lacking.
Most promising: Favorable views exist on pre-Cambrian marginal edges to north and south of region.
Name: SCP's 5-million-acre block of leases.
Formations: Limestone found in three superimposed geological strata:
Most Promising:
1. Secondary basin stretching along edges of Middle Atlas mountains and Hercynian Meseta range, the only outcrops of which are rows of parallel hills—Rides Preiffaines. Tests have proved basin also underlies the more recent and discordant masses of Rharb plain along Atlantic seaboard.
2. Nappe Preriffaine—a large overthrust covering with its considerable salt masses other sediments.
3. A Miocene basin, a last vestige of South Riffan channel.
FRANCE
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ALGERIA
FRENCH WEST AFRICA

SCP Finds 5 New Oil Areas In Morocco During 1955

With domestic crude production furnishing only 7 percent of nation's growing demand, areas are being reappraised in expanding exploratory program.

By MAURICE MOYAL
Marseilles, France

DISCOVERIES of new oil sources, favorable geological indications of others and a growing domestic demand for crude products—which still outstrips supply by 93 percent—have combined to generate a spirit of optimism in Morocco's oil circles.

Société Chérifienne des Pétroles, which holds more than 7 million acres of concessions in the French protectorate, owns exploration and development rights over almost all of the country's sedimentary terrain. Through SCP's exploration program in 1955, five discoveries or extensions were recorded.

1. Wells KH 21 and 22 discovered new oil in the Mesozoic formations in a section northwest of Upper Bled Khatara. Adverse conditions makes commercial development difficult; however, this year SCP plans to bring the new pool into production through a drilling program, using an oil emulsion, phosphate base mud to speed up drilling.

2. The small size of Primary Bled Khatara has made development difficult, but on the eastern boundary, Well KH 25 tapped a new pool to open prospects of development in a northeast direction. Despite the success, production remained pegged at 125 barrels daily on four flowing wells until December. That month, Well KH 27 boosted daily output to 228 barrels. Potential for further increases in both Paleozoic and Mesozoic pools is believed considerable.

3. In March, Well ZR 6, drilled 1½ miles northeast of the eastern boundary of Lower Bled Khatara, found a new pay at 5600 feet. Reservoir rock is conceded to be a highly fractured pink granite.

With only one producing well, the new pool flowed 6000 barrels a day during early tests. However, production soon dropped to 315 barrels daily and subsequently to 125 barrels. From April 1 to December 31, 1955, pro-

duction from ZR 6 totaled 39,164 barrels.

Location of ZR 6 between KH 3 and ZR 1, both dry holes, indicates that the new producing area is limited both along its major north-south major axis and its east-west minor axis. Nevertheless, the 200-foot thickness of the oil-impregnated horizons presages possible further production increases.

4. Late in 1955, Well ZR II in the immediate vicinity of ZR 6 found what is reported to be a separate pool in the overlying Mesozoic formations at the bottom of the Sidi Fili fault. Evaluation of this success awaits further testing.

5. Well BD 129, on the Djebel Bou Draa, overlooking Petitjean, struck oil from a calcareous formation in the Domerian. This commercial discovery, at 2100 feet, resulted from re-examination of prospects which, ten years ago, were regarded as having no possibilities. Placed on pump, BD 129 has been producing slightly less than five barrels a day.

Despite its minor output, prospects for the area are encouraging. It is significant that the operator for the first time has been able to produce oil from an area hitherto regarded unfavorably. BD 129 is expected to increase its production rate during 1956. Significance of this new discovery can be determined only through further development drilling.

If BD 129 has established the existence of oil in the Domerian to the northeast of Djebel Bou Draa, it would constitute too deep an objective to make exploratory drilling worthwhile. However, a detailed seismic survey is proposed this year with a view toward deciding the most likely drilling sites.

In the Outita section, about five miles southwest of Petitjean, Well OT 8 logged oil shows from the Domerian.

It cannot be called a commercial discovery because the pay zone probably is too small to justify commercial development.

Drilling Results in 1955. Last year 39 wells were drilled in Morocco for a total of 184,890 feet. Of this number, 16 wells were exploratory tests, with four resulting in producers; 15 were development wells, and the remainder represented geological drilling.

Exploration-wise, this reflects a drop. In 1954, 35 exploratory tests accounted for 150,686 feet. The 16 tests last year represented a total footage of 102,409 feet. Completion of the campaign in the Oued Beth and the fact that formations encountered did not lend themselves easily to drilling accounted for the decrease in exploratory figures. However, it is significant that average depth of the exploratory tests jumped from 4399 feet in 1954 to 5089 feet in 1955.

Footage drilled by heavy rigs in 1955 was 61,746 feet, as compared with 39,098 feet in 1954; footage drilled by medium rigs amounted to 81,635 feet, as contrasted with 99,410 feet during the previous year; and light rigs accounted for 42,721 feet in 1955 and 107,871 feet in 1954.

At December 31, 1955, eight rigs were active in Morocco. They are largely U. S. rigs and operated by U. S.-trained technicians.

In all three of the most promising zones of northwest Morocco (see illustration), exploratory work has exvealed the presence of limestone horizons where actual oil shows were found. After thorough geological and geophysical study, test wells have discovered oil and gas shows in the Miocene basin, where predominantly marly structures lend themselves to easy drilling.

But whether production is commercial will depend on the presence of such stratigraphic traps as lenses or faults in the sand or sandstone horizons. Well EM 1 opened up a natural gas deposit near El Menzeh, supplying fuel for the Compagnie Marocaine des Cartons plant at Port-Lyautey, on the Atlantic seaboard.

Well BA I opened up another natural gas deposit in the Dogger sandstone at Bou-Draa. Transported through a pipe line to Petitjean, the gas is used at SCP's own refinery. Additional wells drilled in the vicinity of BA 1 disclosed the lack of continuity in gas-bearing horizons. Natural gas production from this area last year amounted to almost 267 Mmcf, as compared with slightly more than 290 Mmcf in 1954.

The discovery well on SCP's holdings in the Rides Preriffaines in the Tselfat hills was completed in 1934. Initially, it flowed at the rate of 1500 barrels a day, but soon decreased. Subsequently, smaller deposits were brought into production at Bou-Draa, also in the Rides Preriffaines, and others at outlying Bou-Hamra, in the Rharb plain.

Together with smaller deposits at Tisserand and Deffaa, these older and partially depleted fields produced only slightly more than 24,000 barrels in 1955.

Stripper Production. Also in the stripper well class are producers in Baton pool, discovered in 1947; Mellah, 1949; Lower Sidi Fili, 1950; and Mers el Kharez, 1951. Last year, these areas produced almost 390,000 barrels. Although partially depleted, these fields are sustaining unexpected steady annual production—about 39,000-46,000 barrels each.

Lower Sidi Fili, the erstwhile No. 1 producing field in Morocco, is experiencing an abrupt decline. From 1952 yield of 377,701 barrels, it slumped to the 1955 rate of only 50,420 barrels. In 1955 the depletion was reflected in a drop of 120,267 barrels from 1954, the record year.

Lower Sidi Fili, and Lower Bled ed Doum, 1952 discoveries; and Lower Bled Khatara, a 1953 discovery and the largest current producer at 183,500 barrels a year, yield more or less steady production.

With output of 41,042 barrels and 1832 barrels, two small 1955 discoveries at Zrar and Bou Draa did not offset declining production of Lower Sidi Fili and other older and partially depleted pools.

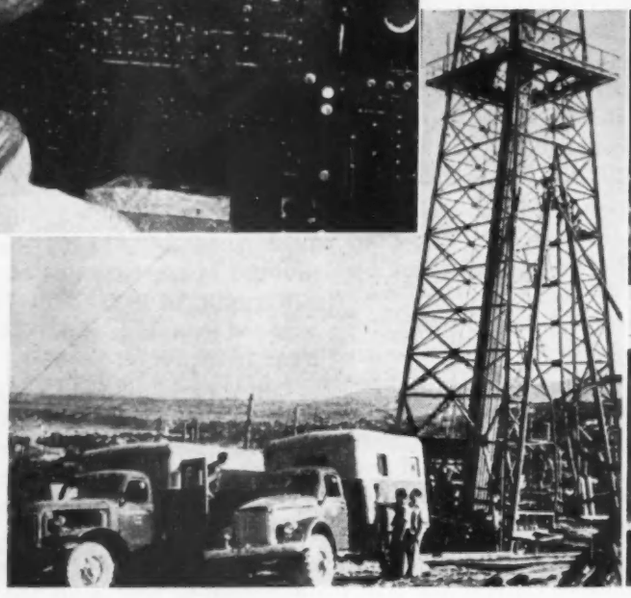
These fields are located in Oued Beth valley, between Rabat and Meknes. All are on the edges of the Paleozoic structures bordering the Jurassic basin. Contact of the Mesozoic formations with the Paleozoic is roughly along the southwest-northeast and northeast directions. The pools extend along a broken line at the bottom of the southwest-northeast fault, which essentially makes up the middle valley of the Oued Beth.

Reconnaissance Program. SCP's active reconnaissance program last year at Oued Beth established the absence of any further pools capable of commercial development. Well DZ tested formations to the north of Mers el Kharez, and BO 2 was drilled between Mers el Kharez and Sidi Fili. Both were dry.

Seismic reconnaissance on the Dar bel Hamri telluric anomaly has discouraged SCP from extending seismic work into area north of Mers el

Continued on Page 185

EXCLUSIVE PHOTOS OF FIRST OPERATION



Technician, above left, inserts a roll of film into the gamma ray unit recorder during the first test of Russian gamma ray logging unit in use in Rumania. Center is the first authentic photograph of Rumania's Russian gamma ray logging unit. The Soviet equipment is logging a well in the Moinesti field, right, the logging crew chief operates the wire line unit while logging the well. A microphone and loudspeaker connect the two trucks and the rig floor so orders can be conveyed quickly.

Gamma Ray Logging in Rumania

The technique, used in the U. S. for the past several years, is introduced into Soviet satellite oil industry and reportedly found effective.

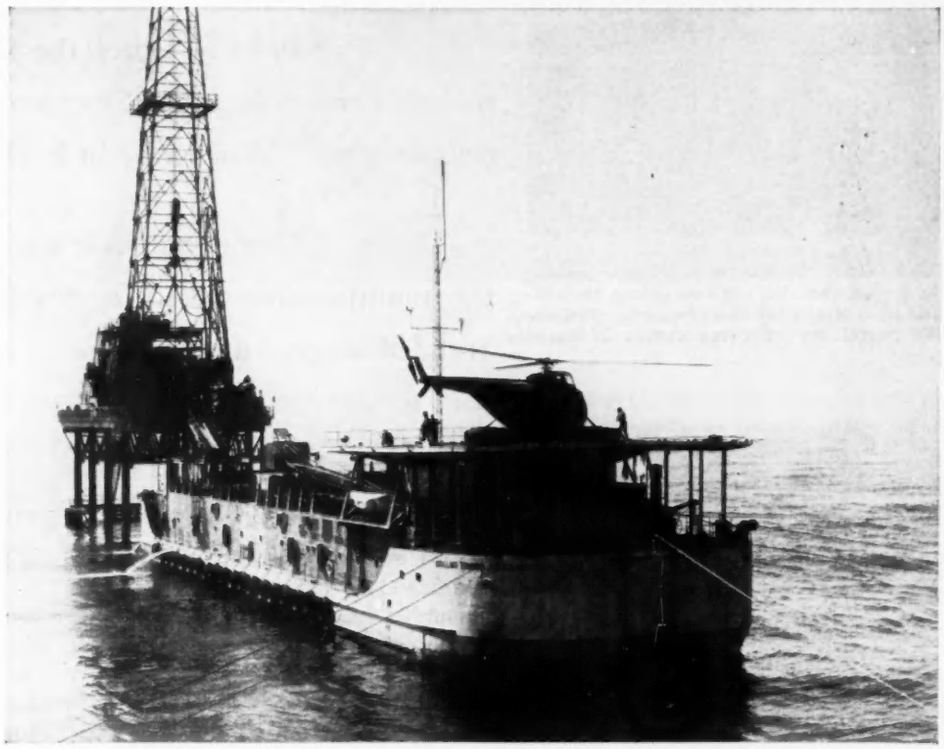
RUMANIA, the first Russian satellite to receive the Soviets' turbine drilling rigs in 1952, late last year also became the first to receive a Russian gamma ray logging unit. Wells drilled before 1930—when electric logging began supplementing mechanical core analysis in Rumania—currently are being logged with gamma rays, particularly those drilled in Moreni, Boldesti, Urlati, and Gura Ocnitei oil fields.

One of the first practical results was announced from Urlati field. There, gamma ray and electric logs revealed that wells had not penetrated the oil horizon to a sufficient depth. At a test well in Urlati, deeper drilling increased production.

The Austrian report of this late development in Rumania—used in the U. S. for the past several years—indicated that the initial Rumanian team for the field laboratory was trained in Russia before attempting the first field operation. **—The End**

TO MOVE MEN BY HELICOPTER

DEPENDABILITY—Sikorsky helicopters, with world-famed operating stamina and inherent flying safety features, have proved themselves on the job in Gulf operations—as well as in jungles and deserts, in polar regions and far out at sea. The Sikorsky S-55, the only helicopter certified by the U.S. Government for scheduled commercial passenger service, is the world's most widely used transport helicopter. Sikorsky helicopters are based solidly on more than 15 years of engineering, production, and operational experiences.



SPEED—Helicopter flights, cruising at about 85 miles per hour, are quick and easy. Crewmen no longer arrive for work at offshore rigs seasick and exhausted from uncomfortable trips many hours long. The availability of transport helicopters enables aerial commuting for more and more oilmen. Men can work on rigs far offshore yet be only a matter of minutes from their families at home.

For more information on Sikorsky helicopters telephone or write B. L. Whelan, general manager, Sikorsky Aircraft.

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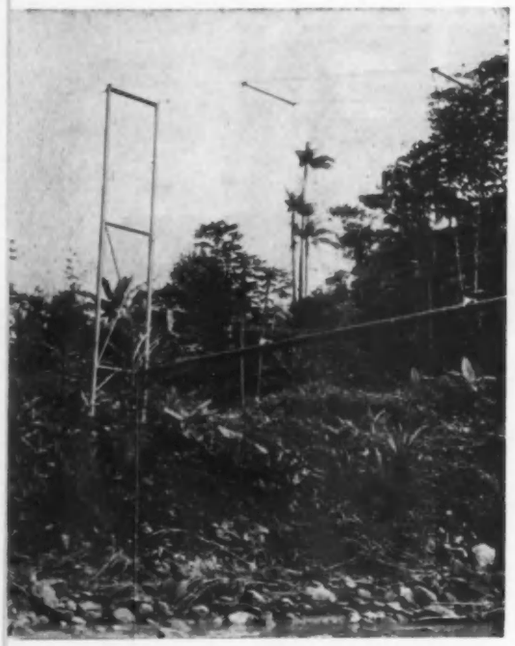


This is one of the suspension bridges spanning the Dagua river. Up this river, along the railroad right-of-way for about five miles, the pipe line crosses the narrowing canyon 21 times.

Colombian Pipe Line One of the Roughest

• In its 64 miles, the $5.2 million Buenaventura-to-Cali project includes 21 canyon crossings, 8 underwater crossings and 13 suspension bridges.

• One seven-mile stretch on almost perpendicular mountainside called for reverse and combination bends and 150-degree angles.

Williams Bros. of Tulsa, Okla., designed this special hydraulic pipe bender on four wheels for the seven-mile stretch along the mule trail. Pipe was cut into 20-foot lengths and hauled up by pack train. Short radius curves of as much as 150 degrees called for different bends on the same length of pipe, reverse as well as combination bends.

ONE SECTION of the 64-mile Buenaventura-Cali pipe line in western Colombia has been described as one of the roughest and most difficult lines of its size ever built.

And this is why:

The first section of the pipe line, owned by Empresa del Oleoducto Buenaventura-Cali, Ltda., of Cali which began operating March 5, 1956, was a 2200-foot underwater crossing to the mainland. The next 28 miles, to an altitude of 1000 feet in the foothills and along the highway right-of-way through low, thick, swampy forest, offered no special difficulties. And about 80 percent of the line pipe was buried.

Up the Dagua river, along the railroad right-of-way for about five miles, the pipe line crosses the steadily narrowing canyon 21 times. For the eight under-water crossings, the line pipe was buried four to five feet deep for protection against rocks swept along during high water. Thirteen bridges, averaging 275 feet in length with a maximum of 525 feet, were of the suspension type with concrete anchorage and galvanized bridge cables.

From a point upriver, called Cisneros, the pipe line follows for seven miles an old, three to six-foot wide mule trail hacked out of almost perpendicular mountainside. From the trail to the valley floor, it is a sheer drop varying between 100 and 500 feet. It was this section that earned for the pipe line the distinction of being one of the roughest and most difficult lines of its size ever built.

The pipe was cut into 20-foot lengths, for the entire seven-mile stretch, and hauled by pack trains. For lashing to the wooden pack saddles fore and aft, the pipe was placed on forked sticks. When these were knocked out, the sudden pull of the weight almost threw the mules, but they managed to negotiate the sharp turns on the narrow trail without a single accident. Only once did a man slip off the path. But apart from a few bruises, he was unharmed.

Since the trail snaked in short radius curves, a high percentage of the 20-foot lengths of pipe needed reverse bends and combination bends, and 150-degree angles were not uncommon.

Williams Bros. of Tulsa, Okla., contractors for the project, designed a special hydraulic pipe bender on four wheels which was pulled along the

mule trail. The pipe was buried in a three-foot deep trench on the mountain side of the trail, after being wrapped with insulating tape and asbestos felt.

The Puerto Dagua station is about three miles east of the canyon entrance and on a slope at an elevation of 2800 feet. From there to Yumbo, ten miles from Cali, the pipe rises to an elevation of 5300 feet to cross two mountain ranges before dropping into the Cauca river valley of Cali at 3300 feet. The pipe was laid along the hard clay slopes, despite some 45-degree inclinations.

Where the grade was too steep, the pipe was joined uphill and pushed down; in other sections, up to four tractors hauled the trucks uphill. In this entire section, the pipe was tied above ground to concrete skids and anchors, and Williams Bros. constructed about ten miles of hard dirt road from the village of Dagua to the north.

The contractors worked out of four successively established camps: the main camp at Buenaventura, a work train in the Dagua river canyon, Puerta Dagua and, finally, Cali. The work force under Supt. Harold Brady numbered up to 200 men.

Apart from pipe line equipment, the 40-pieces of rolling stock included 12 tractors, four cranes, special handling machines and elevating machines.

Fingertip control is afforded by microwave voice radio employing three relay stations. The pipe line currently is pumping with a pressure of 1100-1200 psi about 9000 barrels daily of crude products. With pressure of 1500 pounds, it can handle up to 20,000 barrels daily. It is equipped to pump butane after a market has been established in the Cali area. Total cost of the project, including rights-of-way, was $5.2 million.

The route was laid out by Pipeline Engineering Company of Dallas, Texas, which also wrote the specifications and acted as owners' engineers for Empresa del Oleoducto Buenaventura-Cali, a $2.8 million corporation formed by Colombian capital, International Petroleum (Colombia) Ltd., (a Standard Oil Company of New Jersey subsidiary) and South American Gold & Platinum Company of New York.

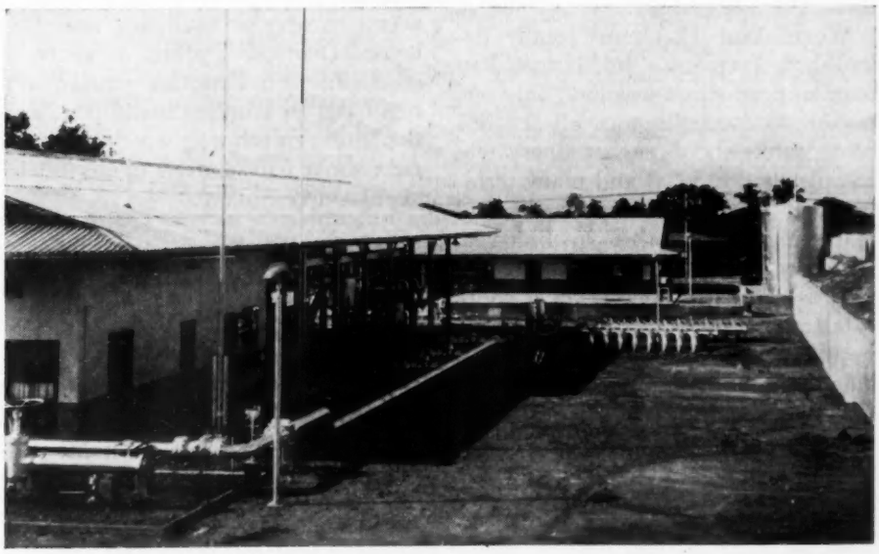
Construction began in March, 1955, and, while the pipe line was finished in January, 1956, delays in auxiliary installations held up the actual pumping until March 5.

Opening a trail for the pipe line through the woods on the Buenaventura side in the lowlands was no easy task.

The main station in Buenaventura has vertical type centrifugal booster pumps and two variable stroke reciprocating main line units. The station at Puerto Dagua has two variable stroke triplex pumps and one quinplex pump. Power at the two stations is supplied by industrial type diesel engines. Pipe sizes are 8-inch between Buenaventura and Puerto Dagua, and 6-inch for the 23 miles to Yumbo. All buildings allow for installation of additional units to a capacity of 35,000 barrels a day.

Construction was from Buenaventura eastward toward Cali. The western, coastal Andes, consisting of two main ranges, also are crossed by a narrow gage railroad and a hard dirt highway, but slides during the rainy season frequently interrupt traffic.

The Buenaventura terminal and pumping station required piling because of soft soil conditions not unusual in an area that experiences a 400-inch annual rainfall. **—The End.**



Note the retaining wall on the right at the Buenaventura terminal. The terrain caused considerable headaches because of a 17-foot cut in that corner where the soil was the consistency of water.

War-Ravaged Petrofina Now Consists of 56 Firms

Belgian group's rapidly increasing and industry-wide operations have expanded to 22 countries and four continents.

By **H. T. BRUNDAGE,** World Oil Staff

The rapid growth of Compagnie Financiere Belge des Petroles (Petrofina) since World War II is almost without parallel. Starting from scratch at the end of the conflict, this unique Belgian group now consists of 56 companies, mostly wholly-owned by the parent concern. They are engaged in every facet of oil business activity. Their operations cover a multitude of areas both familiar and remote.

Petrofina was formed in 1920 to purchase from Swiss interests a company operating properties in Rumania that had belonged to German interests before World War I. In the interim between the two global conflicts, Petrofina became the second largest producer in Rumania, had the largest pipe line system in that country, and its refinery there had a capacity of 50,000 barrels daily. Marketing companies were organized in many European and African countries, another refinery running 10,000 barrels a day was built in France, and a fleet of tankers was acquired.

World War II almost totally demolished Petrofina's holdings. Rumanian production was lost; only one tanker survived the war, all the rest being sunk; the French refinery was completely destroyed and many terminals in Europe were ruined; and marketing companies in Bulgaria, Hungary, and Rumania were lost.

It is difficult to visualize a more catastrophic blow than that dealt Petrofina by the second World War. The group's recovery and growth during the ten short years since V-J day is particularly remarkable in view of the almost total chaos in which it found its plant at the close of hostilities.

Today, the Petrofina group represents, primarily, a refining and marketing concern, with refineries in Italy, Canada, Belgium, and Germany. Petrofina markets in many free European countries, in West Africa, and Canada.

Petrofina controls an important fleet of oil tankers, some of which are company-owned vessels, the others being chartered on a long-term basis. Including vessels ordered but not yet delivered, the total tonnage of this fleet amounts to 823,740 deadweight tons.

As the group's crude production currently is insufficient to satisfy its refinery capacity, British Petroleum Company, Ltd., is under contract to supply crude and finished products to make up the deficit. The group has large crude reserves in Canada and the Sinai peninsula of Egypt, in Angola (Portuguese West Africa) active exploration is going on and a promising discovery has been made.

Recently the group arranged to purchase 75 percent of the stock of Ruhrbau G.m.b.H., whose main asset was a refinery at Mulheim, near Cologne. Deutsche Purfina is to be a wholly-owned Petrofina subsidiary registered to handle distribution, and the Mulheim refinery, which normally runs about 6700 barrels daily, will be expanded considerably.

The remarkable diversity of activity is shown by some of the group's varied holdings, as follows:

- Ownership of a substantial interest in the first petrochemical company in Belgium, Petrochim.
- Operation of a modern research laboratory near Brussels, Belgium.
- Ten percent ownership of the Portland and Montreal pipe line.
- Extensive pipe line, storage, and marketing facilities in the Belgian Congo.

Petrofina headquarters are at Brussels, and the company is capitalized at $300 million. There is a 12-man board of directors. L. B. Wolters, a managing director and one of two Petrofina vice presidents, has been largely responsible for the company's postwar expansion outside Belgium.

The group is quite active in North America. In Mexico, participation has been acquired in Aminol, a domestic company, and several discoveries have been made. Crude is sold locally to Pemex. In Canada, the group has a large stake, through Canadian Petrofina, which was formed in May, 1953, with an initial capital of $25 million. The authorized capital has quadrupled since the formation of Canadian Petrofina.

Now, through its 96 percent participation in Western Leaseholds Ltd., and 91 percent in Calvan Consolidated Gas and Oil, Canadian Petrofina has a net reserve of more than 60 million barrels of crude, plus substantial gas reserves, and a daily net production of 10,500 barrels in Western Canada. It has participated in the drilling of 120 wells in the Pembina field and expects to drill 90 more.

At Montreal, Canadian Petrofina's refinery went on stream during the fall of 1955, running 20,000 barrels per day. In addition to the topping and vacuum plants, the ultra-modern refinery has a 16,500-bpd Houdriflow unit, ultraformer, catalytic polymerization unit, hydro-desulfurization unit and an alkylation plant. A fluid coker is being built, too. Middle East crude is being run.

Two major discoveries were made by the group in 1955.

1. National Petroleum Company of Egypt, a subsidiary of International Egyptian Oil Company (30 percent owned by Petrofina) completed a discovery on the Sinai peninsula in January for 2100 barrels daily from 40 feet of oil sand at 7300 feet. A very substantial reserve is indicated by subsequent development work.

2. During the summer, Carbonang, controlled by Petrofina, brought in two good oil wells from below 8000 feet near Luanda, Angola, after three years of exploratory effort on its 30,000 square-mile concession along the coast. This discovery may be very significant from a world marketing standpoint as well as from a geological one.

Curiously, the Angolan production is over 2600 miles from the nearest production and, as the crow flies, the Sinai discovery is almost as close to the Luanda strike as any other production (e.g., Algeria).

Undoubtedly, the Petrofina group will continue to grow. In 1956 the group plans to set up a company in the U. S. It is expected that the new company will acquire producing properties here.

In Angola, bids are being accepted on a new refinery to be constructed at Luanda to process the newly-found local crude, and a new corporation will be formed in accordance with concession terms. It is noteworthy that the discovery here is closer to the South, and West African markets than any other current source, and, by water, it is about as close to the potential southern South American market as Venezuelan crude is.

In Italy, the four refineries bought by the group there, with a total capacity of 30,000 barrels daily, will continue to be expanded and modernized. Petrofina's tanker fleet is being enlarged, too. **—The End**

INDIA

Continued from Page 175

way can be made if there were a willingness (and there is) on the part of the U. S. oil industry to discuss other ways and means and offer assistance outside of the framework of our government agencies.

Can Industry Help? With the apparent rigidity of the present U. S. foreign policy and its variation in administration by different agencies, it is certainly within the field of realistic thinking for the oil industry to consider seriously the sponsoring of its own technical-aid program through an industry committee or organization representing the entire industry and many contributing industries such as the API. This committee or organization could then take the calculated risk of helping a country develop its petroleum resources without the barrier of political ideologies that retards such discussions before they start in governmental spheres. Many ramifications to this basic idea exist. There is no reason why such an industry policy could not be worked out that would be compatible to the free enterprise system, the U. S. government and the foreign governments concerned.

Through such an organization, it would be entirely possible to invite officers of foreign governments who are responsible for their countrys' oil development to visit the U. S. The visits, at industry's expense, would include Canada, Venezuela and Arabia. The U. S. system of free-enterprise, with its benefits to the public, could be seen at work. Such an organization also could handle foreign governments' requests for technical aid without the procrastination, hesitation and unrealistic attitude that such requests now receive. Assurance already has been obtained from international oil companies that such a policy would receive favorable consideration and a willingness to contribute financially to its success.

Geology Can Wait. Geology, having its own pecularities, is not subject to the changing political climates. Hence, a discussion of the petroleum geology of India here is not apropos. When man-made difficulties can be settled to mutual satisfaction, geology, like an old friend, will be patiently awaiting our solutions.

The Indian government and its people cannot develop their own petroleum resources economically without outside help. The U. S. oil industry will have to take the calculated risk of showing the way. Else India will capitulate to the Communist concept. **—The End**

MOROCCO

Continued from Page 177

Kharez, Sidi Fili and Bled ed Doum Paleozoic pools.

But geologists have been encouraged to re-appraise the region in the immediate vicinity of Petitjean, a few miles east of Oued Beth in the hope of finding new fields outside this mainstay of Morocco's crude production.

In the Gueddara area 12½ miles east of Petitjean, Well GD 2 established the possible existence of a series of Jurassic reservoirs, under Aquitanian cover, in the general direction of Dar en Nsour. Subsequently, a detailed seismic survey and a series of core holes drilled on the flanks of the Dar en Nsour structure uncovered a sizable dome surrounded by an almost unbroken belt of promising stratigraphic traps. The reconnaissance campaign also uncovered possibilities of still another series of reservoirs in the Dogger, overlain by the Nappe Preriffaine.

Complexity of this Nappe makes geophysical interpretation a difficult task. However, stratigraphic test MB 1 between Oueds Mikkes and Sebou, will be decisive in assessing value of the formations underlying the Nappe.

In the Moulouya basin, detailed geological and geophysical reconnaissance on the Tassenart-Ras Maadid structure resulted in a location being staked at Tamd a feit on the southwest section. Although it hit water at 9030 feet, the well established hitherto unsuspected thickness of the Permo-Trias, running to more than 3000 feet. A second test was scheduled at Taoura Merija to study the northern edge of the Upper Atlas trough.

Traps May Exist. Preliminary work, including geophysical field studies and aerial photography has been under way in the Mogador synclinal area. Seismic work has established thickness of the Upper Jurassic and Lower Cretaceous, as well as existence of good cover rock in the Middle Cretaceous. In the general west-east direction, a series of stratigraphic traps may exist.

Detailed geological work also is being conducted on the Ait Lamine and Tagraga structures in the Sous basin. The studies, which began in November, 1955, have resulted in preparation for the first test in the Sous plain. The well will be drilled this year.

A 4-inch, 15-mile pipe line has been laid from Sidi Fili field to the Petitjean refinery, which operates only on domestic crude. To improve and upgrade products, including motor fuel, and to add process flexibility, SCP erected a new catalytic cracking unit. In mid-1954 this unit was put on stream.

Since the refinery fulfills only 7 percent of the domestic demand for crude

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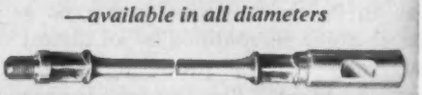

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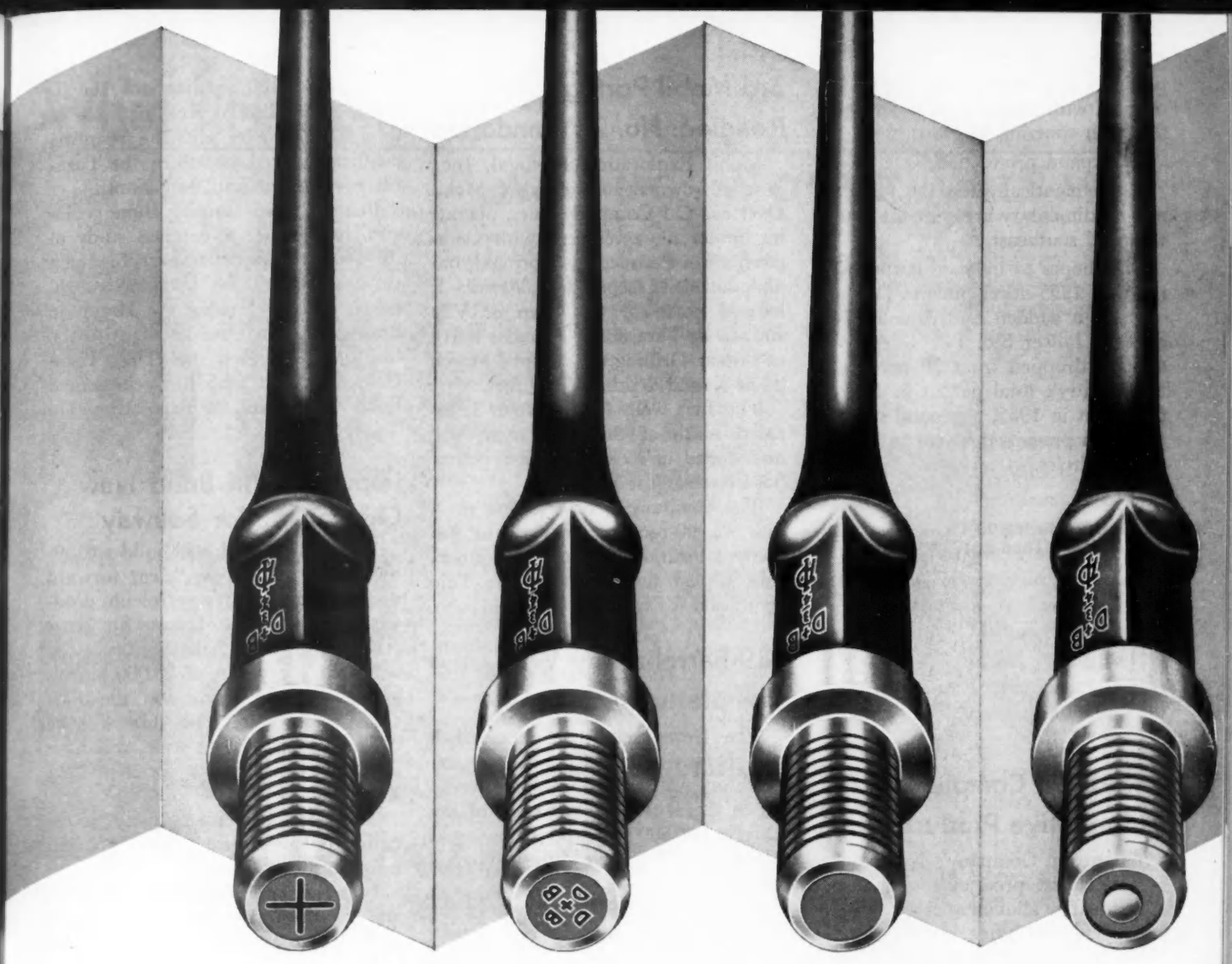

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products, the large market potential, coupled with depletion of older fields, has been spurring SCP to:

1. Expand production.

2. Systematically test the more remote sedimentary areas in the southwest and southeast.

SCP hopes to increase output as a result of 1955 developments. Dimmed only by a sudden and dramatic decline of Lower Sidi Fili, where production dropped from 50 percent of the country's total output in 1952 to 6 percent in 1955, a general spirit of optimism prevails this year in Morocco's oil circles.

Morocco Producing 20 Times More Crude Than in 1939

Year	Crude Production in Barrels Daily
1939	100
1950	786
1951	1,512
1952	2,073
1954	2,400
1955	2,076

Assam Oil Completes Nahorkatiya Producer

Assam Oil Company's Nahorkatiya 11, the latest producing well in the Assam valley alluvial area where eight producers and three dry holes have been completed, is producing from standstone rocks at a depth of between 9660 feet and 9785 feet.

Meanwhile, Assam Oil's Well 12 at Naoholia, in the Hugrijan oil prospecting license area of Upper Assam, has set a new deep drilling record for India. At its depth of 11,855 feet, this well, which is not yet completed, surpasses the record previously held by Assam Oil's Nahorkatiya 1 discovery well, which was drilled to 11,715 feet in 1953.

If Well 12 at Naoholia is drilled beyond 12,666 feet, the depth of Lakhra 1 in Sind, Pakistan, it will become the deepest well ever drilled in Asia. Well 12 began drilling November 3, 1955.

The new Nahorkatiya producer was completed January 2 at 10,360 feet and for its depth was the fastest well ever drilled in India. Further production tests will be carried out on the well, which was shut in so the derrick and equipment could be moved to the site of Nahorkatiya 14. The latter was scheduled to begin drilling about the first of March.

3rd Mobil Portugal Test Readied; No. 2 Abandoned

Mobil Exploration Portugal, Inc., a wholly-owned subsidiary of Mobil Overseas Oil Company, Inc., operating under an agreement with Companhia dos Petroleos de Portugal, has abandoned its second well, Arruda 1, located north of the town of Vila Franca de Xira about 30 miles north of Lisbon. Drilling was stopped March 20 at a total depth of 7009 feet.

The first well, Pinhal Novo 1, located south of the Tejo river, was abandoned in rock salt at a depth of 5531 feet August 5.

The company is now setting up a new 12,000-foot capacity rig at Barreiro 1 location, about six miles outside Lisbon just south of the Tejo river, and is expected to spud in soon.

189-Barrel-a-Day Well Completed in Germany

The Gewerkschaft Brigitta (Shell and Jersey Standard affiliate) exploratory well Eilte B5 has discovered oil in the Delta-Cornbrash of the Dogger at 5600 feet, and is flowing at a rate of 189 barrels daily through a quarter-inch choke.

Located two miles northwest of the Eilte oil field and three miles north of Suderbruch field, the well was drilled in an effort to locate the outcrop of the Suderbruch sandstone farther north. The sandstone was encountered about 1000 feet higher than in Suderbruch field. Details on the extension of the field await further drilling.

Bolsa Chica Awarded 5 Oil Permits in Turkey

Bolsa Chica Oil Corporation, Los Angeles, has been awarded five petroleum exploration licenses in southeastern Turkey covering a total area of 612,000 acres.

Two of these licenses are in the Iskenderun area on the Mediterranean shoreline. Three, in a block of 368,000 acres, are in the Siirt district on the northwesterly trend of the Iraq fields and about 30 miles west of Garzan, one of Turkey's two presently productive fields.

Last September the company obtained an exploration permit and applied for licenses under the recently enacted Turkish Petroleum Law. More than 180 applications for licenses were filed at that time by 12 foreign companies and the resulting conflicts delayed awards by the Turkish government until last month.

Bolsa Chica is sending three geologists to conduct a detailed study of its Turkish properties over the next eight months. The company's field party will be headed by Hampton Smith, formerly chief geologist of the California division of The Texas Company, and who has represented Bolsa Chica in its negotiations in Turkey.

Imperial Will Build New Oil Tanker for Seaway

Imperial Oil Ltd. will build a 6150-ton tanker of a new, "clear forward deck" design to carry petroleum products on the Great Lakes, St. Lawrence river and Atlantic Coast. It will have a capacity of 50,000 barrels and will enter service on the East Coast next year. The ship will be 375 feet long, 52 feet wide, will have a 22-foot draft, and a speed of 12¼ knots.

The St. Lawrence Seaway, to be completed next year, allows a maximum draft of 27 feet.

Imperial now owns 11 tankers on the Great Lakes and East Coast, three on the West Coast and two ocean ships.

Stanvac Stakes Location For Test in Pakistan

Standard-Vacuum Oil Company announced plans to drill a deep test ten miles north of Jhudo in Sind Province, West Pakistan. A 140-foot standard derrick, substructure, complete drilling equipment, and drill-crew accommodations were assembled at Houston, Texas, and the first shipment of equipment was en route to Karachi. Contractor is Southeastern Asia Drilling Company.

The rig will be equipped with a diesel-powered drawworks and a 60-inch hydraulic brake. A complete prefabricated camp is being sent, and all buildings are portable, being mounted on skids. Drilling was expected to start about June 1.

The location is on a 10,000 square-mile West Pakistan concession granted to Stanvac by the Pakistan government. The latter shares in exploration costs through 25 percent participation.

What's Happening

AMONG WORLD OIL MEN

James H. Irwin

Gordon S. Emslie

JAMES H. IRWIN has been appointed vice president of drilling for General Petroleums of Canada Limited, with headquarters at Calgary. He has been with the company since 1942, having started as a driller. Since 1950, Irwin has been assistant drilling superintendent in charge of Saskatchewan operations.

William B. Crutcher

GORDON S. EMSLIE replaces Irwin as assistant drilling superintendent in charge of Saskatchewan operations and will make his headquarters at Bienfait, Saskatchewan. Emslie has been in the oil industry approximately 19 years and has been in the employ of General Petroleums of Canada Limited since February, 1942, serving in various supervisory capacities and as toolpusher for the past nine years.

To fill the vacancy occasioned by Emslie's appointment, ALBERT W. SCHAFFLER, a driller who has been with the company since 1948, has been promoted to toolpusher.

WILLIAM B. CRUTCHER has been appointed manager of contracts. Crutcher has had varied experience with the company since starting in 1941, having been chief purchasing agent for a number of years and, until his recent appointment, serving as assistant manager—drilling.

•

NORMAN HARDY, vice president of the Arabian American Oil Company, has been elected executive vice president.

Hardy began his oil career in 1926 as a geologist with the Standard Oil Company of California. He has worked in Indonesia, Holland and South America, as well as in the U. S. Prior to joining Aramco in 1951, Hardy was president of the Richmond Petroleum Corporation, a subsidiary of Standard Oil Company of California. His headquarters will continue to be in Dhahran, Saudi Arabia.

•

LLOYD G. SMITH, vice president and director of Creole Petroleum Corporation, has retired after 43 years service.

Smith began his career with the Standard Oil Company (Indiana) as a draftsman at the Whiting refinery in 1913, immediately following graduation from the University of Illinois with a B.S. degree in mechanical engineering.

He held positions as chief draftsman, foreman of the boiler shop, combustion engineer and general foreman of the Light Oils Treating department at the Whiting refinery of Standard Oil Company (Indiana) until February, 1922, when he transferred to the Casper refinery of Standard Oil Company (Indiana) as general foreman of the Light Oils Cracking and Lube departments. He remained in this position until 1927 when he transferred to Pan American Petroleum & Transport Company's New York office as assistant manager of manufacturing in charge of refineries at Aruba, Tampico, Baltimore, Destrehan, Savannah and Harburg, Germany.

In 1932, when the foreign properties of Pan American were purchased by Standard Oil Company (New Jersey), Smith transferred to the New York office of Standard Oil Company (New Jersey) as assistant in charge of operations at Aruba and Tampico. In 1933 Smith transferred to Aruba, N.W.I., as general manager of Lago Oil & Transport Company, Ltd.'s Aruba refinery. In 1934 he was elected a director of Lago Oil & Transport Company, Ltd., and became president of that Company on July 1, 1944.

In 1947 Smith transferred to Creole Petroleum Corporation as vice president and manager of refining in the company's New York office. He also was named a director of Creole in 1947.

•

Thomas E. McDowell

THOMAS E. McDOWELL, partner, Petroleum Overseas Consultants, Houston, Texas, returned early in June from a business trip to Cuba. While in Cuba, McDowell toured the island's various oil fields.

•

DALLAS E. HAWKINS, II, has been appointed general manager of Fargo Oils Limited, Calgary, Alberta.

Dallas E. Hawkins

He has held executive posts with four companies since moving to Canada in 1951. For the past two years he has been assistant to the superintendent of operations, Sun Oil Company, Canadian division. His other Canadian appointments were: superintendent of operations, Canadian Delhi Oil, Calgary; general manager, Scandia Drilling Company, Calgary; and general manager, Mid-Western Industrial Gas Company, Edmonton.

After graduating with distinction in Chemical Engineering in 1944 from the Rice Institute, Houston, Texas, he obtained the degree of Master of Science in petroleum engineering at University of Michigan in 1947. He obtained experience in the oil industry in the fields in Illinois and Indiana. Later he was junior engineer for Magnolia Petroleum Company and prior to moving to Canada was chief engineer, Comanche Corporation, and later, superintendent of operations, H. S. Moss Petroleum Company, both of Dallas, Texas.

DRILLING HINTS

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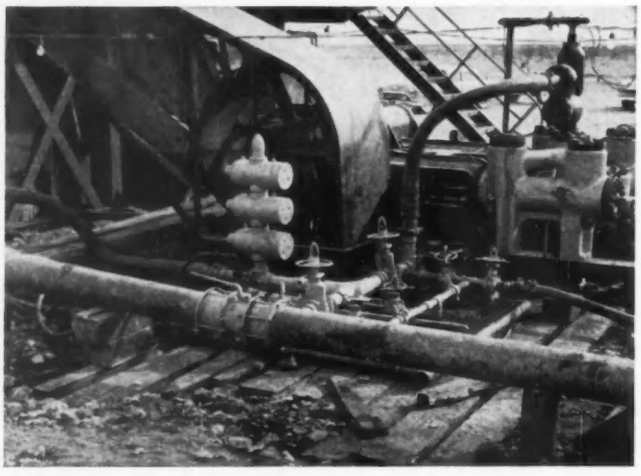
Unitize Piping System for Mud Pumps



Operators are finding that unitizing their mud lines so that connection work and line laying are held to a minimum saves a considerable amount of time and labor.

One operator has arranged his system of valves, bypasses and pulsation dampener on a skid mount so that they can be moved as a unit. The discharge lines from the two pumps and the discharge lines from the manifold to the stand pipe are rubber hose. By using flexible connectors, the manifold skid can be set down between the two pumps and the rubber hoses connected to the system with hammer-up unions. Alignment is no problem.

An added advantage, besides a saving in rig-up time, is in the operation of the pump valves. The pumps can be changed, or a pump can be changed from circulating to mixing, or jetting the pits, without having to run from one pump to the other. All valves are conveniently located in one central spot.

A savings in pipe fittings also is realized as fittings do not get lost or the threads banged-up during moves.

Doghouse-Junk Box Unit Eases Moving

In the trend toward unitization of all rig equipment for faster moves and faster rigging up, one contractor has been very effective in unitizing the junk box and doghouse. The junk box is of regular construction, a skid-mounted pipe frame with six 3-inch pipe legs supporting the skid-mounted doghouse mounted above.

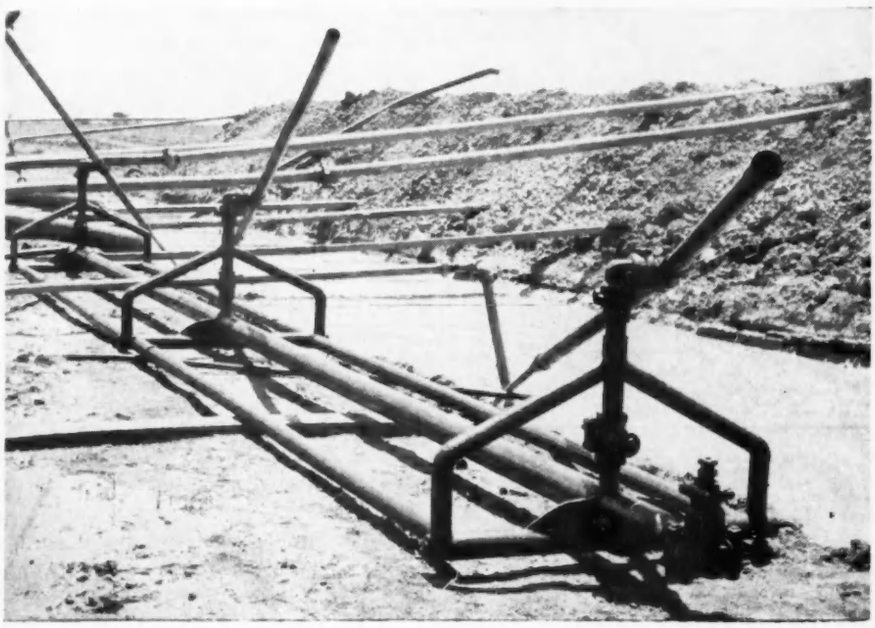
These 3-inch legs are approximately eight feet long and telescope inside 4-inch pipe that forms part of the framework for the doghouse. The 4-inch pipe is welded into each corner of the doghouse and on each side in the center. The 3-inch pipe extends up into the 4-inch. Holes have been drilled through the 3-inch pipe at various heights so that steel pins can be inserted through them.

When tearing down on this rig, a gin pole is used to pick up on the doghouse, a matter of an inch or so; the steel pins are removed from the holes in the 3-inch legs; and, as the doghouse is lowered, the 3-inch telescopes up into the 4-inch. When the doghouse comes to rest on the junk box, the 3-inch legs extend approximately to the top of the doghouse. Note the tops of the 4-inch pipes in the photograph.

In this way, it takes but a few minutes for the gin pole to raise the doghouse, the crew to remove the pins and then settle the doghouse on the junk box. The unit then is ready to be pulled up on a truck and moved.

How-To-Do-It Ideas Earn Money, too!

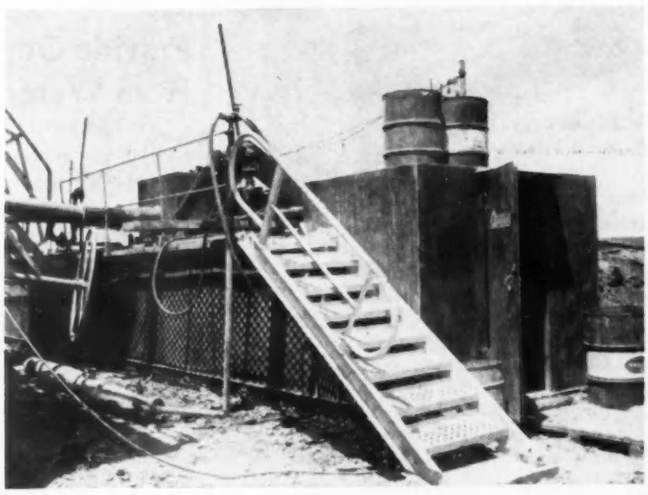
$10—WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of that latest idea and send it in with a picture or drawing of the installation . . . if accepted, $10 will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Mount 3 Mud Guns on Pipe Framework

In some areas where earthen pits still are used for mud rather than steel tanks, and the laying of mud and water lines for jetting the pits can run into a considerable amount of work when rigging up or tearing down, provide a labor-saving device. Unitize three mud guns into one framework so that they can be picked up and moved in one piece. Space these mud guns approximately 12 feet apart and mount them in a pipe frame with pipe braces supporting the guns. It is necessary only to connect these into the mud pump discharge system when moving on to location.

Build Mud Lab Onto Mud Tanks



One contractor has unitized his mud tanks very effectively to incorporate a small mud and sample lab. A small doghouse about four feet deep is built onto the end of the first mud pit. It is slightly over six feet tall and located adjacent to the shale shaker. Here the derrick man or the mud man can catch samples at the shaker and take them into this doghouse that is outfitted with running water, a sink, lights and mud testing equipment.

Samples can be washed and either hung up for future inspection or dried on a hot plate in the doghouse if desired. Mud samples caught at the shale shaker can be brought in for full mud testing as all mud equipment is stored in the house, a convenient place to keep equipment in good condition away from wear on the location. It also provides a handy place to work out of the weather.

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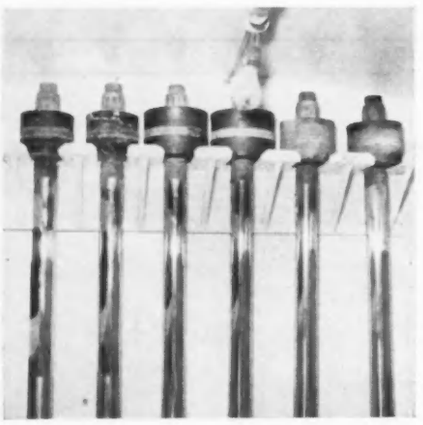
THE ORIGINAL COMPOSITION CUP

Rig Spare-Parts Rack for Pump Rods and Plungers

Proper maintenance of equipment around a rig is very important, the same applying to proper care and handling of spare and stand-by parts, particularly pump rods and liners. To provide an effective means of keeping spare plungers and rods in good condition and at the same time to place them out of the way of the crew during drilling operations, cut out a piece of non-skid floor plate, approximately eight inches wide and five feet long, and notch it as shown in the photograph. Use pieces of angle iron to form a lip on the outer edge of this plating to keep the plungers in place.



Weld a piece of angle iron the same length as the rack on the doghouse wall. Weld the notched floor plating above this and use ¾-inch pieces of discarded sucker rod to brace the outer edge of the extended plating to the angle iron welded below to form a hanger for the spare rods and plungers.

This arrangement not only provides a safe storage place for pump parts, but also enables the operator to know at one glance what is on hand and the condition it is in. It also enables the crew to keep the rods and parts oiled to prevent rusting.

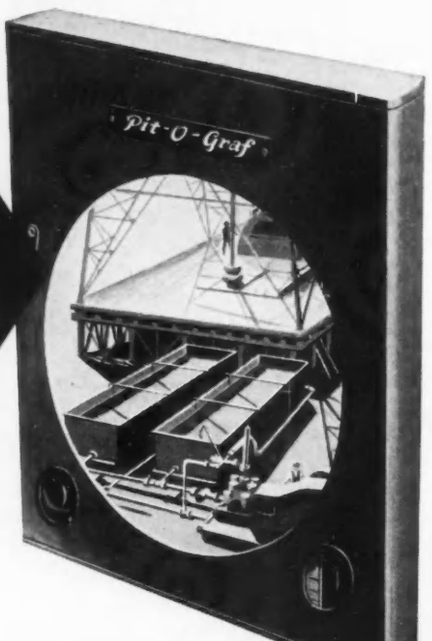
Provide Outside Drain From Water Can Holder

To prevent necessities like salt tablets, water cans, paper cups, etc., being scattered all over the doghouse, mount a water can in the corner of the doghouse with paper cups and salt tablets mounted nearby. To eliminate the usual dripping and splashing of water onto the benches and floor of the doghouse, make a trough of 3-inch pipe and place it slightly below the water can holder. By placing the trough lower, large cups or glasses can be used when getting water, but any excess water is dripped into the trough.

Weld the trough to the doghouse wall and drill a hole of approximately ¾-inch diameter through the wall. Connect a ¾-inch pipe into this hole and attach a hose so that the water can be drained away on the outside.

"Pit-O-Graf"

RECORDS CONTINUOUS INSPECTION OF MUD PROGRAM



Continuous evaluation of the planned mud program by the driller is made possible by: 1., Instantaneous recording of mud pit level variations (as little as 2 or 3 tenths of one per cent in the entire mud system); and, 2, Pit-O-Graf is placed directly in front of the driller for easy observation.

Pit-O-Graf's continuous record helps prevent unnecessary losses of the drilling fluid. Gas or salt water incursions can be detected as much as an hour and a half to two hours before reaching the surface, giving the crew ample time to close the rams and prevent blowouts. Other information such as jetting mud to and from reserve pit, volume displaced thereby, and whether hole is kept full while coming out of the hole is also recorded by Pit-O-Graf.

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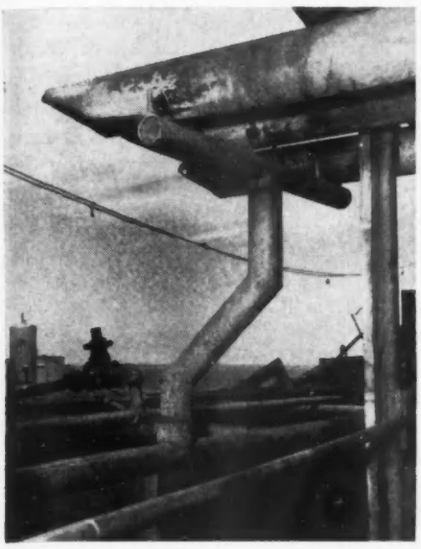


Brace Engine Exhausts With Scrap Pipe Unit

One contractor with a small rig found an easy way to brace engine exhausts. In this particular case the mud tanks were located adjacent to the engine shed where the exhausts actually extended over the edge of the tanks.

A 3-inch collar was welded to the 3-inch pipe that formed the top framework of the tank. Short sections of 3-inch pipe were cut and welded into the resulting dog-leg brace as shown in the photo. When screwed into the collar on the tank, the top of the brace extended about 12 inches towards the engines. A cross piece of 2-inch pipe was attached to the 3-inch upright and small pieces of scrap were rounded out and welded to the cross arm to form a cradle for the exhaust pipes.

When moving the rig, the exhausts are removed and the brace is unscrewed and dropped into the empty mud tank and moved with the tank to the next location.

Bin for Waste Rags Aids Safety Program

Neat and well-kept locations have very few accidents. Practically every drilling rig has wiping rags and waste handy for work around the equipment and for keeping oil and grease wiped up where it has spilled or splashed. Some operators provide a special place for these rags; others

Tips on Mud Valves for Toolpushers . . .

Tom J. Beaty on the left and driller, L. E. Mariner with a group of MUDWONDER mud pump manifold valves.

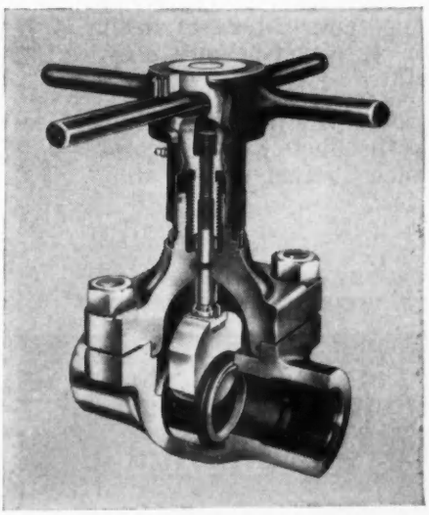
Slim Hole Rig Sets Drilling Records with 2000 PSI Mud and MUDWONDER Valves

By Tom J. Beaty, partner, Rig #1, Slim Hole Drilling Company, Houston, Texas

SINCE we rigged-up our new slim hole rig last July we have been setting records regularly on amount of hole per day and top to bottom time. One of the big reasons for these records, we feel, is the Rockwell-Built MUDWONDER mud valve which is used on all our mudlines.

This valve has done a remarkable job for us without downtime or repairs. It's easy to operate—we use 2000 psi line pressure regularly and never have any trouble. Besides, the one-piece body does away with body misalignment and keeps repairs or part replacements, if needed, simple and quick.

MUDWONDER cut-away view shows the double thread construction, separated stainless stem and hard chromed gate with "T" slot connection and the one-piece seat insert with the buna-N molded integrally over the steel wear rings.



For economy—and economy is the main reason for slim hole drilling so we are extremely conscious of it—we equipped our new rig with MUDWONDER mud valves. We are using them on the pump manifold, the stand-pipe, the fill-up line and the blow-out preventer manifold very successfully.

I can recommend MUDWONDER to any toolpusher having mud valve trouble. MUDWONDER valves are built in 2″, 3″, and 4″ sizes with screwed or flanged ends and ratings of 2000 psi WP (4000 psi test) and 3000 psi WP (6000 psi test).

See your favorite oil field supplier for complete information, or write Edward Valves, Inc., East Chicago, Indiana.

leave them in the box in which they are brought to the rig.

One operator built a bin in his doghouse that fits in among the small parts shelves. This bin is approximately 27 inches long and the same depth as the shelves. Top half of the front of the bin is a hinged door with a locking hasp. After the rags are placed in the bin, the door is locked. On the lower part of the front of the bin, a sliding door allows the rags to be pulled out singly.

The door was made by welding two pieces of strip metal so that they extended out from the bin approximately the thickness of the plate. A circular hole was cut in the front of the bin and the small door was inserted under the metal strips. Ends of the strips were crimped down so that the door could not be removed.

This arrangement provides a neat and effective storage place for the rags—one that is well kept at all times and is easily refilled. Rags are readily available in the doghouse when needed.

Vise on Side of Pipe Bin Provides Handy Work Area

When rigging up around a location and a considerable amount of pipe work is necessary, provide a handy work area. On the sides of the pipe bin mount a heavy duty pipe vise that can hold up to 4-inch pipe. Along the sides of the bin, and spaced about eight feet apart, place two "L" shaped swinging arms that can be turned out to the side of the bin, raised to the proper height, and a pin inserted in the leg to hold them in place. Lay pipe being worked on along this rack with the end held in the pipe vise for threading or making-up operations.

Make the table that the vise is mounted on of steel plate with two 2-inch pipe legs bracing the outer edge. Make the swinging arms out of 2-inch pipe with short lengths of 3-inch pipe welded against the pipe bin frame into which these arms are fitted.

When not in use, swing the arms back over the top of the pipe bin where they are out of the way of the crew working around the rig.

GONE FISHING! .....spells TROUBLE in Drilling Operations

Yes—thread failure on drill collars and tool joints *can* mean troublesome, costly fishing jobs—and sometimes complete loss of expensive drilling strings.

A break-out of galled and frozen joints costs money through shut down—damaged threads mean replacement of drill collars and pipe.

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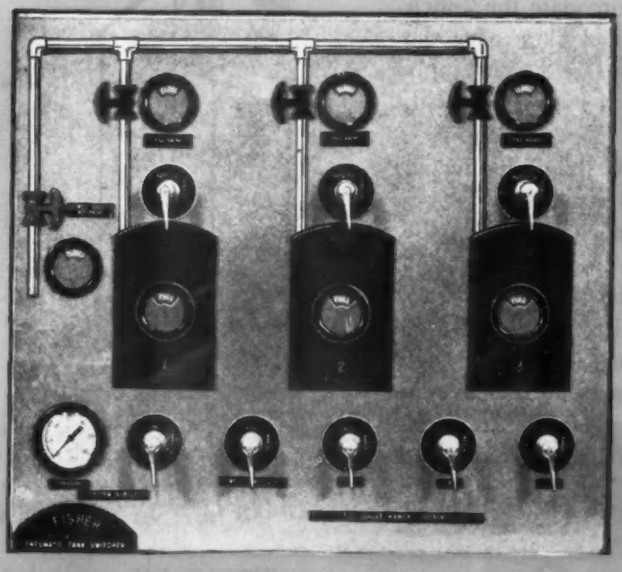
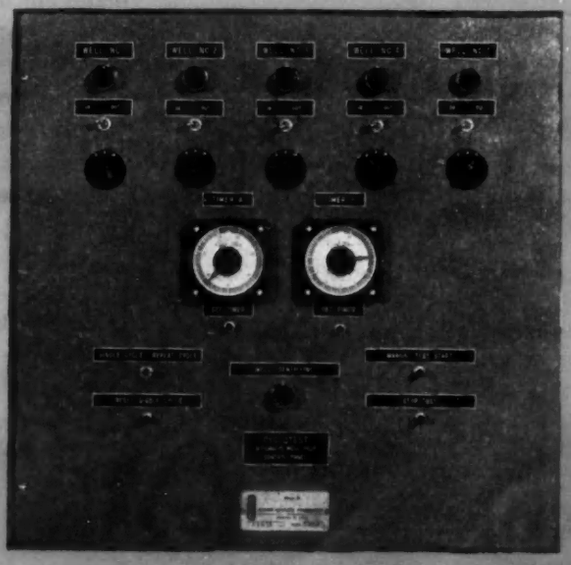


Pneumatic Tank Switcher

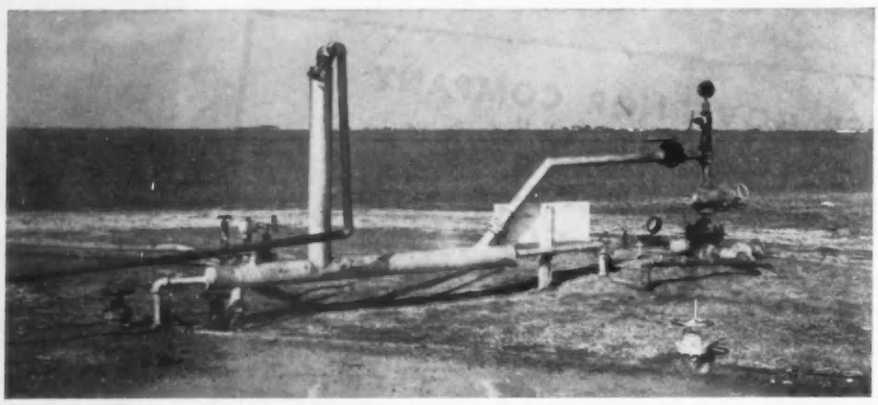


Cyclotest Electric Well Test Controller

PRODUCTION HINTS

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.



Combination Device Aids Field Operations

The illustrated device is being used in the Texas Gulf Coast on edge wells which produce large quantities of sand and salt water cut with gas. It greatly reduces the amount of sand reaching the separator and prevents the casing line choke from freezing up in cold weather.

To construct this unit, weld two pieces of 6-inch pipe to form an unbalanced T with an offset to accommodate the flow line as shown. Weld a short 4-inch drain line on the underside of the unit at the end opposite the flow entry.

Place a length of 2-inch pipe through the horizontal arm of the unit, letting it extend about two feet beyond the casing at each end. Seal the ends of the casing with metal plates cut to accommodate the 2-inch tubing. Put a similar plate over the end of the riser with a 2-inch nipple attached to allow a connection with the separator line.

In this manner, well fluid is affected by turbulence and a decreased velocity causing it to deposit sand in the horizontal section of the tank. To clean this material from the unit, open the drain valve and flush it into a pit. The gas line running through the trap helps create turbulence in the well fluid. It also acts as an exchanger by absorbing warmth from the well fluid and transmitting it to the gas being injected into the well.

How-To-Do-It Ideas

Earn Money, too!

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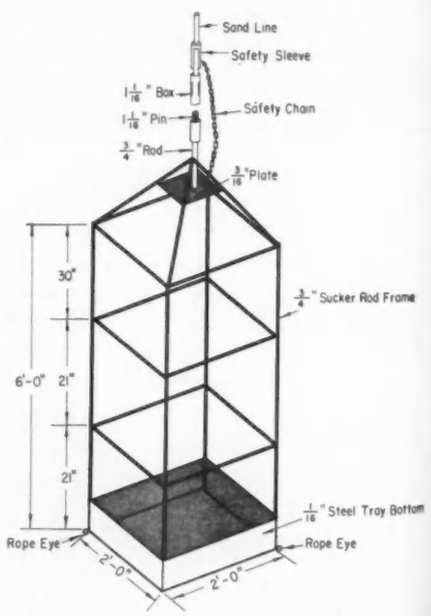
Make Safety Elevator Of Sucker Rods, Plate

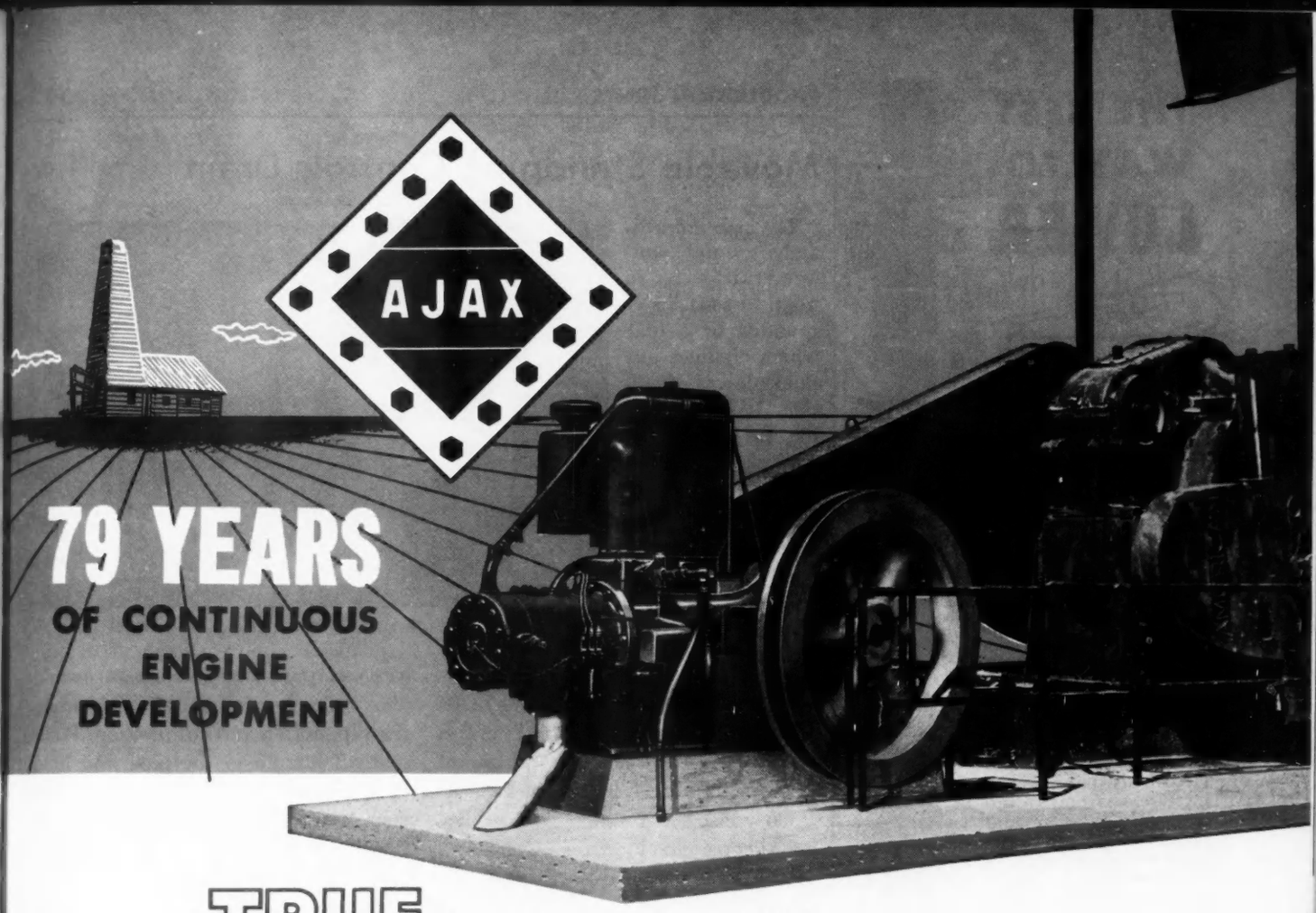
Very often when rods and tubing are being stripped, position of the rods makes them extremely awkward to break. Occasionally, a make-shift monkey board is moved up and down the derrick and the man on it forced to work in dangerous positions to unscrew the rod joints.

To eliminate this hazard, a crew built the elevator illustrated. By attaching it to the sand line, a member of the crew can be raised from the floor to the proper height to unscrew the rod joint and can be returned safely when the joint is broken. After the man is safely on the floor, the operation may be continued.

The elevator is made of sucker rods and steel plate welded into a sturdy



unit as shown. To prevent the elevator from rotating or swinging while being raised, ropes are attached to the eyes at the bottom of the elevator.



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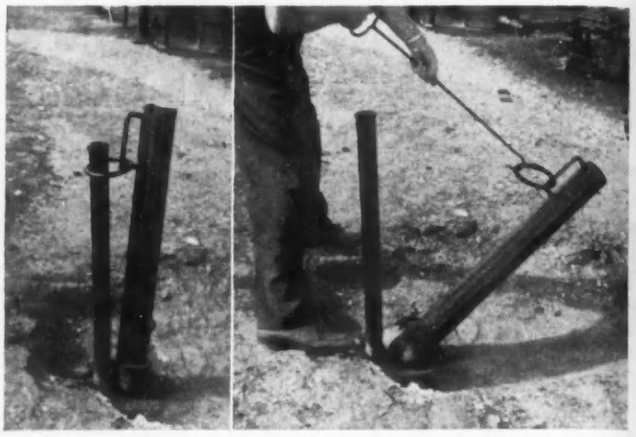
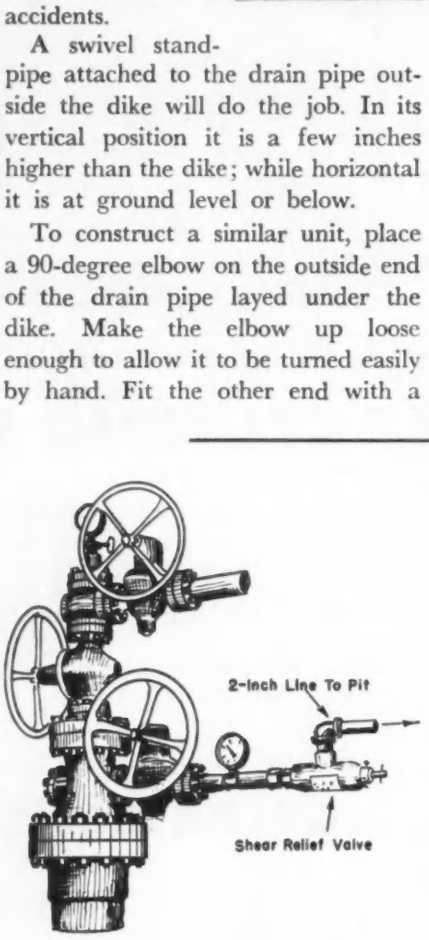


The area immediately around storage tanks is, in most cases, surrounded by a dike which confines any fluid deposited inside. It is desirable to have drainage facilities which can be controlled so that water can drain after a rain but the oil be retained in case of accidents.

A swivel standpipe attached to the drain pipe outside the dike will do the job. In its vertical position it is a few inches higher than the dike; while horizontal it is at ground level or below.

To construct a similar unit, place a 90-degree elbow on the outside end of the drain pipe layed under the dike. Make the elbow up loose enough to allow it to be turned easily by hand. Fit the other end with a piece of pipe long enough to extend above the height of the dike when the pipe is in a vertical position. Weld a small handle to the pipe and fit a ring through it as shown. Loop this ring over a stake driven in the ground next to the standpipe to keep the pipe vertical when not in use.

Another tool that can be used with this installation, is a hook to raise the standpipe out of the oil, mud or water.



Use of Shear Relief Valve Prevents Casing Damage

During acidizing and fracturing treatments under a packer, occasions have arisen when the packer suddenly gave away or the tubing ruptured and the released pressure caused damage to the casing.

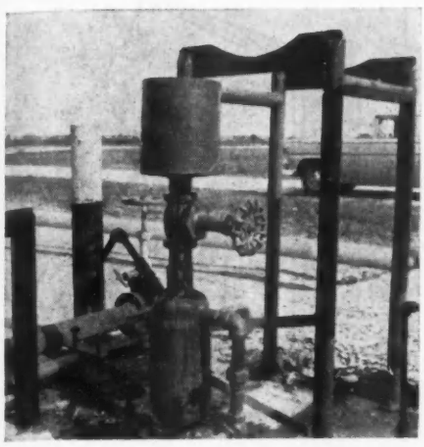
To eliminate this possibility, use a relief valve. Attach a shear relief valve, similar to the ones used on mud pumps, to the casing line and open the casing line valve. Set the relief at a pressure lower than the casing yield strength. If for any reason undue pressure is built up in the casing, the relief valve will open the casing line and release the excess pressure.

The accompanying sketch illustrates the position at which the relief valve is installed.

Use Radiator as Heater To Shake Out Base Oil

A trick that will save time when shaking out base oil is to heat the oil in a shakeout glass instead of in a bucket or some other such container. To heat the glass, simply take the cap off a car radiator and put the end of the glass in for half a minute. The engine has to be hot, of course, before the method can be used.

A word of caution, don't accelerate the car engine when the glass is in the radiator.



Build Inexpensive Unit To Aid Inhibitor Injection

The illustrated measuring tank and lubricator form a simple, inexpensive unit for injecting the correct quantity of fluid into a line.

Make the measuring tank from a piece of large diameter pipe with a 2-inch nipple welded to the plate forming the bottom of the tank. Screw a valve on the nipple and close it. Then, with the tank in a level position, pour a quart of water into the tank and mark the level on the inside wall. Repeat the process, adding a quart each time until the tank is full. Empty the tank and weld a small piece of rod at each mark to calibrate the tank for future use.

The lubricator can be casing or pipe with flat plates or swages welded to the ends to fit the outlet and inlet nipples. A fitting is required near the top for the inlet from the flow line as shown on the right of the lubricator pictured. Opposite this inlet is a pressure bleed-off line. This line allows pressure in the lubricator to be released without going through the measuring tank which might still contain fluid.

Shop-Made Surge Tank Saves Stuffing Box

Water is often a difficult thing to pump and when put through a meter near the well head it can cause considerable stuffing box trouble. In an emergency this problem can be solved with some sort of make-shift surge tank. An example of such a tank is illustrated above.

The tank is made of two 2-inch by 3-inch swages, two 3-inch collars, a short 3-inch nipple and a 2-inch valve. Assemble them as shown and install the unit in the flow line between the well head and the meter. This allows the surge of fluid to be taken up by the tank and relieves the pressure shock from the stuffing box.

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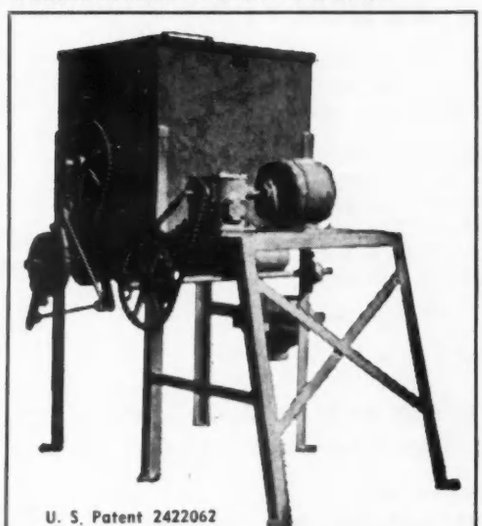
For complete description see Page 2777 of the Composite Catalog.



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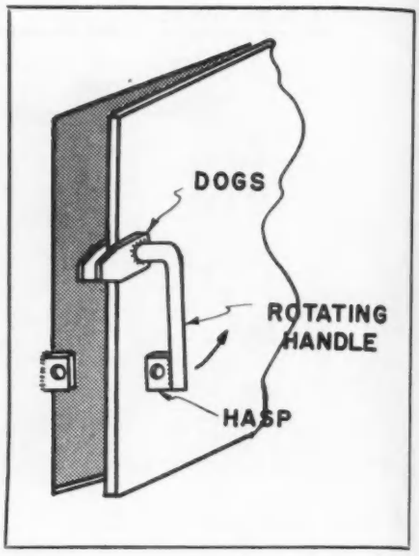
Simple Lock Safeguards Tool Shed

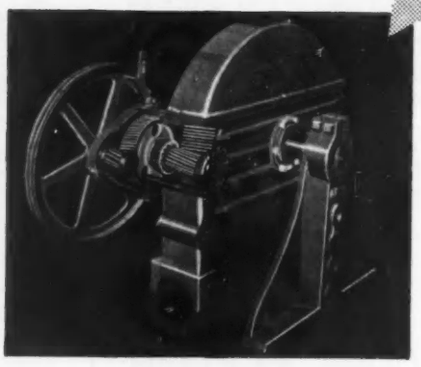
A rotating handle fitted with dogs and a hasp makes an ideal locking device for sheetmetal doors or covers.

Cut a 9-inch piece of ½-inch reinforcing rod and bend it 90 degrees six inches from one end. Slip the short end through a hole drilled in one of the steel dogs made to fit the door and weld it to the rod as shown. Leave enough space to allow the rod to pass through a hole in the door and the second dog. Weld the inside dog to the rod and the rotating door handle is made. Weld a small piece of steel plate to the inside of the handle, preferably at the end, and a matching piece to the wall of the shed. Drill a hole through both pieces to accommodate a lock.

When the handle is rotated to the horizontal, the dogs are free of the door frame. In the vertical, or locked position, the dogs come in contact with the door frame keeping the door closed. With the lock in place, the door is fastened securely until the lock is removed and the handle turned.



Another Exclusive JENSEN Feature . . .



. . . DOUBLE GEAR REDUCTION

No wonder JENSEN JACKS have set the pace for economy and efficiency for more than 36 years—they're loaded with exclusive features that assure top performance.

One outstanding example is the exclusive Double Gear Reduction designed with the second stage main gear of large diameter, reducing tooth pressure and affording greater flexibility of gear ratios. You can change from double to single or from single to double quickly and easily. See your JENSEN Dealer or write us for all the facts.

JENSEN JACKS

JENSEN BROS. MFG. CO., INC.
Coffeyville, Kansas, U.S.A.

Export Office:
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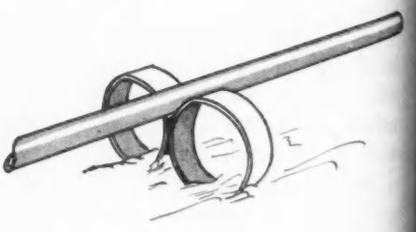


Make Temporary Jig From Welded Pipe Rings

Holding small diameter pipe off of the ground while welding or threading is often quite a task in the field. An effective method used by one Gulf Coast welder saves time and money and is easy to do.

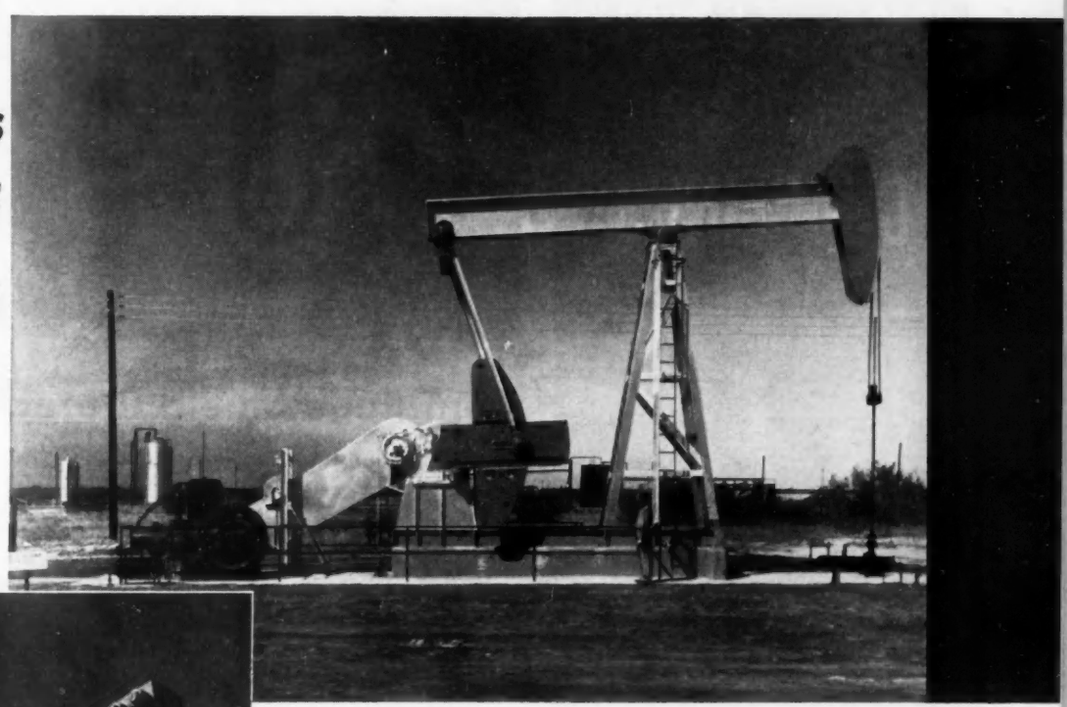
Make a simple jig by welding two-inch wide rings of large diameter pipe together as shown in the sketch. Two or three sets of these units can be made quickly and will readily support the line being worked on.

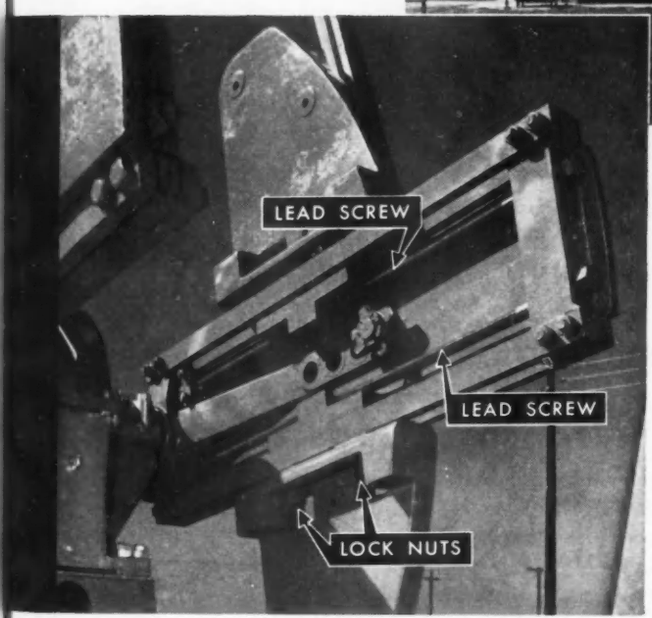
The welded rings also make good stands for pipe being run over small obstacles or other pipe around a tank battery. By choosing the right diameter pipe, height of the line being carried can be regulated as desired. If several lines are running parallel to each other, additional rings can be welded together as necessary.

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

the PARKERSBURG LONG STROKE PUMPERS

worthy additions to a family of outstanding pumping units





THE IMPROVED ONE-MAN CRANK COUNTERBALANCE

Accurate adjustments on Parkersburg's crank counterbalance are easily made by one man with a wrench. All he does is loosen the lock nuts and turn the lead screws which move the weights back or forth to the correct balance. Weights and crank are calibrated to further simplify accurate balancing.

These new long stroke pumpers by Parkersburg are not an adaptation of smaller pumpers, but specifically engineered units for long stroke, deep-well pumping. They have all of the proved design and construction features which have made Parkersburg Pumpers leaders for almost sixty years.

In addition to stronger, heavier construction they have such improvements as equal working centers; improved one-man crank counterbalance and short base mounting for any type engine or electric motor.

Parkersburg Long Stroke Pumpers are available in 120″ and 144″ units. Each has a beam capacity of 32,700 lbs. The 120″ pumper has a peak torque rating of 456,-000″ lbs.; the 144″ unit a peak torque rating of 640,000″ lbs.

Before installing your next deep-well long stroke pumper, be sure to get full information about these new units from your Parkersburg Representative.

Parkersburg
RIG AND REEL COMPANY
DIVISION OF PARKERSBURG : AETNA CORPORATION

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CAPITOL
3000# and 6000#
FORGED STEEL
COUPLINGS

for all
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installations

Both 3000# and 6000# couplings are manufactured to ASTM Specification A-105.

Available in full and half couplings for immediate shipment from stock in sizes:
3000# — ⅛" through 4"
6000# — ⅛" through 3"

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MFG. & SUPPLY CO.
COLUMBUS, OHIO

COUPLINGS — NIPPLES — UNIONS — RADIANT HEAT FITTINGS — FURNACE COILS — WELL SUPPLIES — STEEL PIPE FITTINGS

Centrifuge Shield Protects Operator

The probability of hinges or fingers which hold sample bottles on a centrifuge breaking and throwing parts out in all directions is remote, but possible, and every precaution may prevent an injury.

The safety measure shown here consists of placing a shield around the rotating centrifuge. Should the mechanism break or a bottle shatter, the operator would be protected from the flying debris.

To duplicate this unit, weld a small ¼-inch steel plate on the end of a piece of 2-inch pipe set in the ground as shown. Use 1-inch metal strips to position the shield and weld it in place with the centrifuge as near the center as possible.

The shield is 3/16-inch steel plate about a foot wide with the diameter being dependent on size of the centrifuge. Final assembly should look something like the illustration shown for best results and an easy, inexpensive manufacturing job.

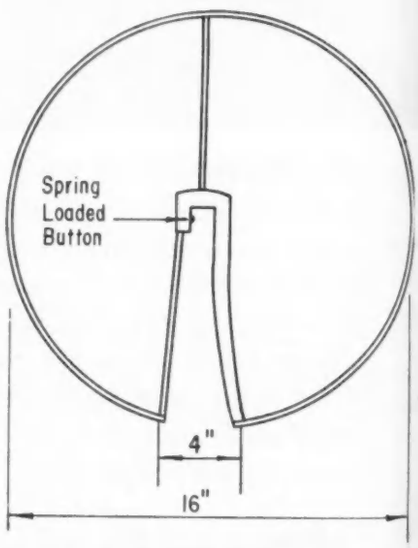
Altered Rod Wrench Speeds Operation

A crew in Louisiana made some alterations on their rod wrench which greatly speeded up operation and made work a lot easier.

A spring-loaded button was added to the wrench which holds the tool in place once it is positioned on the rod. To accomplish this, a hole was drilled in the back of the jaw into which a steel ball and spring were inserted. The spring was held in place by peaning a small plug in the open end of the hole.

A piece of ½-inch rod was formed into a circle 16 inches in diameter. This ring was cut and welded to the wrench, as shown in the illustration, and the tool was complete.

The advantages of this tool are easily seen. It allows more hands to be applied to the wrench at one time and the rods can be spun up much more quickly than can be normally done with an ordinary rod wrench.



NOW stop both corrosion and bacteria problems with just one Armour cationic!

A short cut to water flood profits

No expensive equipment needed! This lightweight chemical feeder is all the equipment needed to control corrosion and bacteria with Armour cationics.

124 water flood systems have proved it! Corrosion protection is as high as 99.5% and bacteria and algae are completely controlled —for as little as 0.7 mill per barrel of water!

Now, you don't have to buy two or more different chemicals to fight corrosion and bacteria or algae growth. In water flooding throughout the petroleum industry, *both* problems are controlled with *one* Armour cationic. And you can use Armac® C50, Duomeen® C50, or one of the Arquads® as the one cationic best suited to your needs.

Armour Cationics plate out on the inner surface of pipes to form a corrosion-resistant, protective film which resists washing away. They give maximum, *continuous* protection at extremely low, economical concentrations. Engineers from 124 water floods report that concentrations as low as 6 ppm. achieve at least 95% corrosion reduction in fresh, brine and produced waters. Sulphate-reducing bacteria, Psuedomonas organisms, algae—major causes of well plug-up—are *completely* controlled. Costs run from only 0.7 to 2.1 mills per barrel of water. You use less labor and there is no need for elaborate and expensive injection equipment.

There's a specific Armour cationic for your specific needs. Send the coupon for information and for our Corrosion Inhibitor Questionnaire which will help us select the best cationic for you. Start taking advantage of the short cut to water flood profits offered by these versatile chemicals.

MAIL THIS COUPON WITH YOUR LETTERHEAD

Please send me:

- ☐ Corrosion Inhibitor Questionnaire
- ☐ Tech. Bulletin E-6 and G-3—Corrosion and Oil Wells
- ☐ Armac Booklet
- ☐ Arquad Booklet
- ☐ Duomeen Booklet
- ☐ Arquad T-2C product bulletin
- ☐ Corrosion in water floods information

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ARMOUR CHEMICAL DIVISION

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What's Happening

AMONG MEN IN THE INDUSTRY

Rollin Eckis, vice president of **Richfield Oil Corporation** and manager of exploration since 1954, has been elected executive vice president of the corporation. With Richfield since 1937 when he was district geologist, Northern division, he became chief geologist in 1946. During the past two years he has directed development of Richfield's expanded foreign exploration which includes operations in Canada, Alaska, Peru, South Arabia and Egypt.

Rollin Eckis

•

L. W. Bennett, treasurer, **Sunray Mid-Continent Oil Company,** was elected a national director of the Controllers Institute of America recently. He was president of the Institute's Tulsa Control in 1953-54, and has been active in the controller's group since 1949.

•

Charles W. Daniel, production foreman for the **Pan American Production Company** of Houston, has been awarded a medal of heroism by the Joseph A. Holmes Safety Association. He was cited for displaying "exceptional courage and skill in rescuing a drowning man and treating him for shock" after a boat in which two men were riding overturned in a reservoir on the Neches river near where Daniel and a friend were fishing. When one of the men began to sink, Daniel dived into the water, brought the drowning man to the surface and took him 200 yards in to shore.

Charles W. Daniel

•

Phillips Petroleum Company announces the promotion of **M. D. Voss** to manager of the Reservoir division in the Economics department at the Bartlesville, Okla., headquarters of the company. He succeeds **C. E. Turner,** whose promotion to manager of the department recently was announced. Voss started with Phillips in 1941. He has been assistant manager of the reservoir division since 1955.

•

Humble Oil & Refining Company recently announced the following changes in Production department supervisory personnel: **R. N. King,** rotary driller, Paradis district, Eastern division, was promoted to toolpusher at Grand Isle district. **Harley N. Reavis,** supervising petroleum engineer, North Texas division office, was promoted to assistant division petroleum engineer in North Texas. Reavis replaces **C. W. Armstrong, Jr.,** who became assistant district superintendent of Winters district. **R. G. Tonkin,** district supervising petroleum engineer, Stratton district, Southwest Texas division, has been made assistant district superintendent at Hobbs district, Western division. **D. D. Cherry,** civil engineer, East Texas division office, was transferred to the Eastern division office, New Orleans, as civil engineer; **S. L. Kennedy, Jr.,** junior petroleum engineer, Kelsey district, Southwest Texas division, was promoted to associate petroleum engineer; and **V. R. Sage,** associate petroleum engineer, Government Wells district, Southwest Texas division, was promoted to petroleum engineer at Government Wells. **C. J. Wooley, Jr.,** supervising petroleum engineer, Petroleum Engineering division, Houston office, transferred to the Stratton district as district supervising petroleum engineer.

•

Wilson K. Minor recently was elected comptroller of the **Standard Oil Company of California.** Assistant comptroller since 1947, he has been in the Standard of California organization since 1924 when he joined Pacific Gasoline Company, a firm subsequently acquired by Standard.

•

Donald L. Kastner's appointment as assistant division production superintendent at Odessa, Texas, has been announced by **Cities Service Oil Company.** Kastner will supervise West Texas production operations as assistant to D. D. Bodie, division superintendent of the West Texas-New Mexico division. Kastner joined the company's engineer training school in 1947, later serving as district engineer at Great Bend and Russell, Kansas, as district engineer at Odessa, and later, as district superintendent there.

•

Imperial Oil Company of Texas has announced the election of **J. F. Epley,** independent oil operator from Midland, as president. **Richard G. Boren** of Houston is vice president, and **Raymond P. Elledge,** secretary-treasurer. Offices of the new company are in the Texas National Bank building, Houston.

•

R. R. Kriesel of Minneapolis and **C. J. Murray** of Sioux City, Iowa, are new directors of **Voss Oil Company,** Newcastle, Wyoming. They succeed Dale H. Voss, former chairman of the board, and Warren G. Voss, former president, both of whom recently resigned. New officers of the company are **Patrick H. Feeney,** president; **A. R. Barnes,** vice president; **Edward S. Halsey,** secretary; **Harry M. Knight,** treasurer and assistant to the president, and **Harold R. Ditto,** assistant secretary and assistant treasurer.

•

L. F. McCollum, president of the **Continental Oil Company,** was awarded an Honorary Doctor of Engineering degree from the Colorado School of Mines as a part of the school's eighty-second annual commencement exercises. The citation pointed out McCollum's activities in professional and civic organizations on both local and national scale, and his work to maintain and strengthen professional standards in engineering.

C. L. (Slim) Clark, formerly with Socony-Vacuum Oil Company in South America and Egypt, has retired and is living at 111 McKinley Place, Monrovia, Calif, from which point he does occasional consulting work in the foreign field.

•

Foster J. Schempf has been appointed general manager of Louisiana operations by **John W. Mecom,** Houston independent oil operator. Schempf has been vice president and director of exploration for Stanolind Oil & Gas Company in Tulsa. As general manager, he will supervise and direct the onshore and offshore activities of Mecom who is active in several major Louisiana fields and is an equal participant in the world's deepest oil well recently completed in Plaquemines Parish. Schempf joined Stanolind in 1933 in Houston. During the next six years he became a geologist and then district geologist in the Tyler office. Between 1939 and 1951 he was a district geologist in Midland, division geologist in Fort Worth, division exploration manager in Houston, district production superintendent at Longview, Central division manager in Oklahoma City and Gulf Coast division manager in Houston. He was named a vice president and placed in charge of exploration for the company in 1951.

Foster J. Schempf

•

Southern California Petroleum Corporation announces the election of **Dwight C. Baum** as a director of the company. He is a partner in Eastman, Dillon & Company, Los Angeles.

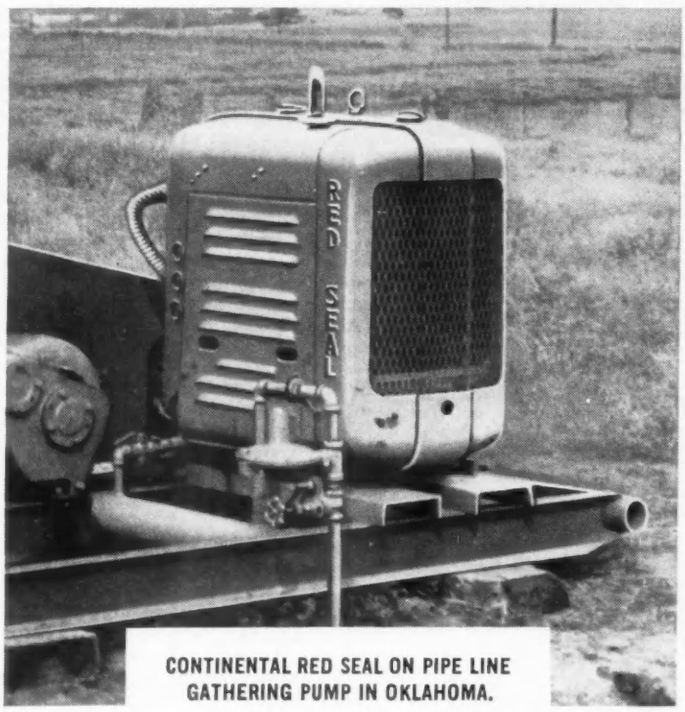
•

Eldon Young, general attorney for **Gulf Oil Corporation** and subsidiaries since 1947, retired from active service June 1. A veteran of 29 years with the Gulf companies, Young was responsible for the corporation's legal affairs and law offices in Houston and Fort Worth, Texas, Jackson, Miss., and Shreveport, La. He joined Gulf's Law department in 1927 after practicing law in Mexico and Texas seven years.

•

Stanolind Oil and Gas Company has named **Roy M. Bauer** field engineer for the Farmington, N. M., area and **John M. Clark,** field engineer for the Hobbs, N. M., area. Bauer was hired by Stanolind as a roustabout-engineer trainee in 1949. He served in various engineering capacities in Andrews, Midland, Roswell and Hobbs prior to his promotion to field engineer at Farmington. Clark joined the company as a roustabout-engineer trainee in 1949 and served in various engineering capacities at Wink, Abilene and Sweetwater. Prior to his move to Hobbs, he was field engineer at Farmington.

YEAR-IN YEAR-OUT DEPENDABILITY



CONTINENTAL RED SEAL ON PIPE LINE GATHERING PUMP IN OKLAHOMA.

CONTINENTAL RED SEAL ON KOBE HYDRAULIC PUMPING UNIT IN TEXAS.

• • •

CONTINENTAL RED SEAL POWER

One reason why you see so many of today's Red Seal engines in the oil fields is the fine performance record of those already on the job. Red Seals are engineered for reliability, economy and long life. They span a horsepower range from 10 to nearly 300. They're built for operation on all standard fuels. And they're backed by service and genuine Red Seal parts from coast to coast. Ask your oil field supply store, or write for information.

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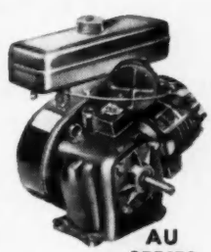
A COMPLETE LINE OF 4-CYCLE AIR-COOLED ENGINES FOR HEAVY-DUTY APPLICATIONS

Continental also builds small air-cooled engines, 2 to 3 hp., especially suitable for compressors, pumps, and other jobs where long-continued use with minimum attention is required. Automatic ignition cutoff stops engine when crankcase oil falls below safe operating level. Now available with built-in generator for charging battery and operating lights. For information, write Air-Cooled Industrial Engine Division, 12800 Kercheval Ave., Detroit 15, Mich.



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Continental Motors Corporation

MUSKEGON • MICHIGAN

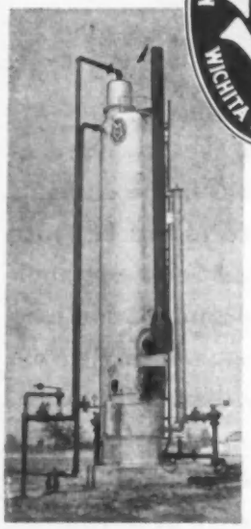
CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD

6 EAST 45TH STREET, NEW YORK 17, NEW YORK • 6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 3817 SOUTH SANTA FE AVENUE, LOS ANGELES 58, CALIFORNIA • 1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GEORGIA

Be **SURE** of Trouble-Free Performance

Specify . .

MFD BY McV TANK COMPANY M & V WICHITA FALLS, TEXAS



TYPE P-V

PRESSURE TREATERS

M & V Pressure Treaters have an unbeatable record of trouble-free performance. They are designed to operate automatically with a very minimum of supervision . . . built to the most exacting standards . . . and offer you the finest possible assurance of full recovery at lowest cost.

MFD BY McV TANK COMPANY M & V WICHITA FALLS, TEXAS

Steel Fabrication for the Oil Industry

Richard E. Rhea, manager of the Corporate Records and Organization department and former assistant secretary of **The Ohio Oil Company,** is the company's new secretary. He succeeds **H. H. West,** who will continue as vice president of the Administrative Services department and a director. Rhea joined Ohio Oil in 1932 in the Marketing department of the refinery at Robinson, Ill. He since has worked in many varied areas including refining, purchasing, warehousing, advertising and was secretary to O. D. Donnell, former Ohio Oil president. Rhea was appointed assistant treasurer in 1952, assistant secretary and manager of the Corporate Records and Organization department in 1953.

Richard E. Rhea

•

Bernard F. Shearon recently joined the Employee Relations department in the Coral Gables office of **International Petroleum Company, Limited,** as compensation supervisor. Shearon moved from Esso Standard Oil Company's Bayway Refinery where he was head of the Wage and Salary division. Beginning his oil industry career in 1935, Shearon has served with Lago Oil & Transport Company, Standard Oil Company (New Jersey) and with Esso Standard Oil Company. He transferred to the refinery in 1951.

•

Ralph T. Hanson has been appointed assistant manager of production for **Continental Oil Company's** southwestern region, with headquarters in Fort Worth. Formerly a member of Conoco's western region staff at Los Angeles, he succeeds S. V. McCollum who recently transferred to Houston as production manager for the company's CATC marine region. Hanson joined Conoco's production department at Seal Beach, Calif., in 1934. He has held a succession of production positions with the company in California, including drilling foreman, regional petroleum engineer and regional production manager.

•

C. L. Clausel now is administrative assistant in operations of **Housh Drilling Company,** Portable Bridge & Equipment Company, Housh oil producing and other enterprises. Retiring as president of A-1 Bit & Tool Company in January, 1955, he since had been active as an independent oil operator and drilling contractor in oil fields south of San Antonio. In the oil industry since 1919, Clausel organized the A-1 Bit Company in 1932. With the purchase of Universal Core Barrel Company in 1946, the firm changed its name to A-1 Bit & Tool Company and Clausel was elected president and chairman of the board.

C. L. Clausel

•

H. M. Van Clief, succeeding **H. S. Stark** as superintendent of the California division of **Honolulu Oil Corporation,** joined the company in 1922. After working in the oil fields in a roustabout gang, in production operations and on drilling crews, he was made resident engineer in 1925. He later was placed in charge of Honolulu's drilling operations in California, a position he has held until his current advancement to superintendent of California field operations. Stark has retired from active employment with Honolulu after 33 years of service. **C. F. Meacham,** advanced to a newly created position of assistant superintendent of the California division, was employed as a roustabout by the company in 1934. He later served as civil and construction engineer, becoming head construction foreman in 1950.

•

Frank M. Brooks, newly-elected vice president and director of **Sterling Drilling Company,** will headquarter at the company's office in Sterling, Kansas. Brooks enters the Sterling organization after 20 years in exploration and production phases of the industry. Early experience was obtained in areas extending from Kansas to West Virginia with Gulf Oil Corporation and Bridgeport Oil Company. The past ten years have been spent with The El Dorado Refining Company from which he recently resigned as director and vice president in charge of exploration and production.

•

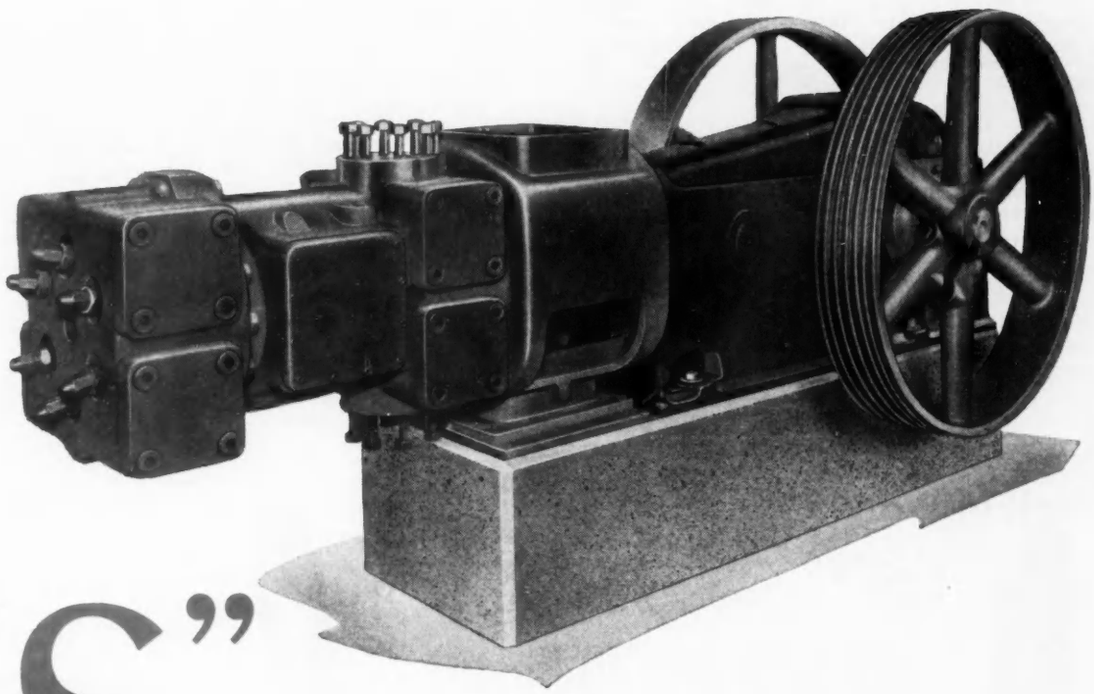
Frank Darden has been appointed reservoir engineer for **Newmont Oil Company** at Fort Worth, Texas. Prior to his recent position as reservoir engineer for Empresa Colombiana de Petroleos, El Centro, Colombia, Darden was with the Murphy Corporation in Montana and Humble Oil & Refining Company in West Texas.

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

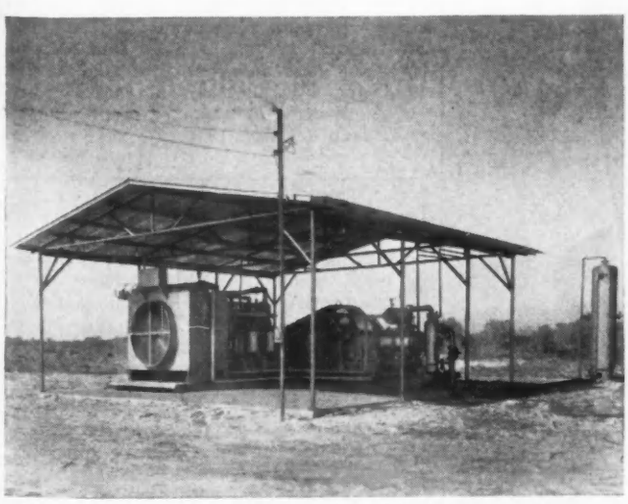
ABILENE, TEXAS
Hudson-Eads, Inc. ----------2-5331
CORPUS CHRISTI
Tubokut Wireline Services----------5-1811
HOBBS
Horne Well Service Co.----------3-5396
MIDLAND
Luccous Service & Equipment Co.-------2-1631
PETTUS, TEXAS
Eddie Jones Engineering Co.-16 or Beeville 1547
OKLAHOMA CITY
Rainbo Service Co.----ME 4-2131, ME 2-3045
LIBERAL, KANSAS
Rainbo Service ----------Main 4-3598
WICHITA FALLS
Hudson-Eads, Inc. ---2-3767, 2-8584, 3-4690
CASPER, WYOMING
C. A. White----------3-5264
GLENDIVE, MONTANA
C. A. White----------EMpire 5-3833
FORT MORGAN, COLO.
C. A. White----------919



"ES" compressors

are the workhorses for . . .

- **GAS LIFT**
- **FLARE GAS**
- **FIELD GATHERING**
- **REPRESSURING**



Ingersoll-Rand ES compressors are widely used in oil field service. Above is one of hundreds of packaged plants built by Wilson Supply Co.

They work, work, and keep on working day after day, and year after year. Ingersoll-Rand built them that way. The ES was specially designed for continuous heavy-duty service, and the reputation of thousands of units in service prove it. They last for years, even when roughing it in the oil fields.

Attendant free . . . trouble-free . . . Hundreds of ES compressors are on services in the oil fields where an attendant comes around only once a day, or perhaps only a couple times a week. And when general inspection or overhaul is advisable, the Ingersoll-Rand "ES" is so easy to get at.

Most versatile compressor you can find . . . Above is an ES with a booster cylinder for pressures up to 1500 psi . . . specially made to meet oil field demands for versatility. Of the liner type, its construction permits a wide range of cylinder diameters without loss in performance and efficiency. You can change liners and pistons in any machine shop to meet new pressure conditions . . another reason you can get the most for your specific conditions. The ES can be belt-driven as a single unit or two of them can be combined for two-stage compression.

When you need another compressor, be sure it's an Ingersoll-Rand ES.

Four stroke sizes . . 20 to 150 horsepower

Ingersoll-Rand

1-415 **11 Broadway, New York 4, N. Y.**

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

Loffland Brothers Company announces the appointment of **Warren Perry** as manager of operations. Perry, who has been superintendent of the Oklahoma division of the company, began his career in the drilling industry in 1930 when he joined the Loffland organization. He worked in various parts of south and West Texas as well as New Mexico until he was made superintendent of the Oklahoma division in 1947. Perry will be succeeded as superintendent in Oklahoma by **Charles D. Brown**, who entered the employ of Loffland Brothers in 1929. He will make his headquarters in Oklahoma City.

Warren Perry

•

Creole Petroleum Corporation recently announced the election of **Nicholas J. Campbell, Jr.**, as a director of the corporation, effective May 1. Campbell began his service with Creole in 1947 as an attorney in the New York office. In 1950 he was transferred to the Caracas office where he was appointed assistant manager of the Law department, and he was made manager of the department in 1953. In January this year Campbell was elected a vice president and transferred to the New York office. He succeeds **Lloyd G. Smith** who retired as a vice president and director April 30 after 43 years' service.

John C. Maher, U. S. Geological Survey, will assume new duties as Mid-Continent regional supervisor in Denver about July 1. He has been in charge of central Mid-Continent investigations from Tulsa for the past 12 years. **Ernest E. Glick,** who will succeed Maher as supervising geologist in Tulsa, has been engaged in both surface and subsurface geology of northern Arkansas five years. His new duties will include supervision of studies of the geology and fuels resources of the Anadarko, McAlester and Arkansas Basins.

•

A. E. Pettit, formerly assistant to the president of Louisiana Land and Exploration Company and at present a consulting geologist in Houston, was employed recently as staff geologist for **Sohio Petroleum Company.** He will be assigned initially to the company's offshore venture in New Orleans. Formerly with Hamilton Gas Corporation, Magnolia Petroleum Company and Cooperative Refinery Association, Pettit later was Western division geologist for Louisiana Land and Exploration in West Texas and the Rocky Mountains.

A. E. Pettit

•

George H. Cobb, assistant to the president of **Kerr-McGee Oil Industries, Inc.,** has been assigned duties and responsibilities of uranium exploration formerly performed by **J. C. Finley,** vice president in charge of exploration. Departments which formerly reported to Cobb will report temporarily to **J. H. Lollar,** secretary-treasurer.

•

Richfield Oil Corporation directors have elected **Cleve B. Bonner,** who has been secretary since 1937 and a director since 1941, to the office of treasurer. They also named **Norman F. Simmonds,** who has been assistant to the president since 1940, secretary of the corporation. Bonner has been with Richfield since 1937 when he joined the corporation's legal department. Prior to joining Richfield, he was engaged in a private law practice in Wichita, Kansas, and served in the legal department of Sinclair Refining Company in Kansas City, Mo. Simmonds joined Richfield's Right-Of-Way department in 1928 and served as manager of that department in 1929-30. He transferred to the land and lease department in 1931 and served as assistant manager of the department from 1937 to 1940.

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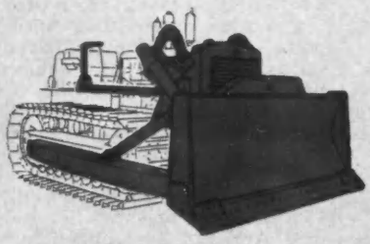
Two-Week Course

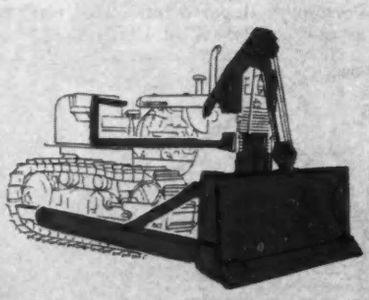
Dr. Sylvain J. Pirson and Jack Grynberg are jointly offering a two-week, eight-hour-day course on quantitative electric log and radioactivity log interpretations and dipmeter computations at the Commodore Perry Hotel in Austin, Texas, July 23 through August 3. The course is limited to 24 people and is being offered to geologists and petroleum engineers alike. Inquiries concerning the course or registration should be addressed to Jack Grynberg and Associates, 1340 South Santa Fe Drive, Denver 23, Colorado.

.42 new blades

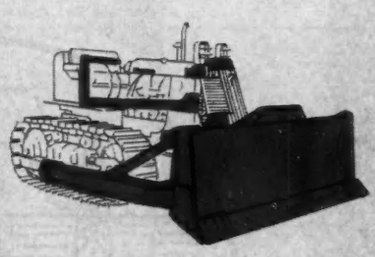
Bonus-Powered International crawlers



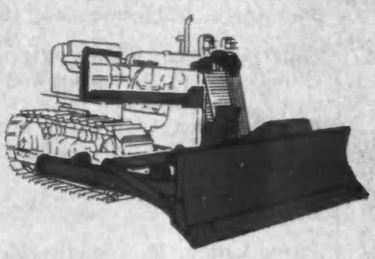
Direct Lift Hydraulic Bulldozer
Operates off front-mounted, gear-driven pump which gives fast blade action. Self-aligning bearings prevent binding of linkage.



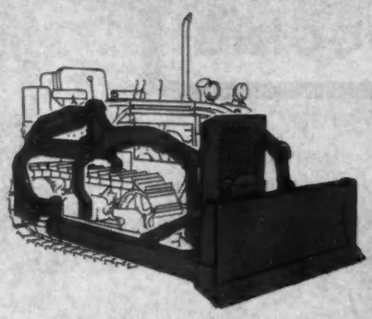
High-Gantry Cable Bulldozer
Operates off either front or rear-mounted International cable control unit. Available for TD-24, TD-18, and TD-14 tractors.



Low-Gantry Cable Bulldozer
Operates off either front or rear-mounted International cable control units. Available for TD-24, TD-18, and TD-14 tractors.



Hydraulic or Cable Bullgrader
Operates off high or low gantry, front or rear cable controls on TD-24, TD-18, and TD-14 tractors. Hydraulic bullgrader also for TD-9, TD-6, and T-6 tractors.



Track Frame Mounted Bulldozer—Distributes the load evenly over the length of the tracks. Available only for TD-9, TD-6, and T-6 tractors. Bullgrader also available.

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Newest of International Drott loaders. Combines Skid-Shovel, Bull-clam, clamshell, and bulldozer in one unit. Available for TD-14, TD-9, and TD-6 tractors.

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DEATHS

Robert H. Greenwood, 35, assistant controller of Sahara Petroleum Company, a subsidiary of Continental Oil Company, died May 21 in Cairo, Egypt. He was with Conoco at Ponca City, Okla., four years before becoming assistant controller of Sahara in Egypt in 1954.

Dr. August A. Schaerer, 52, died May 15 in Orinda, Calif. At the time of his death, he was employed by Shell Development Company at the Emeryville Research Laboratories. With Shell since 1928, he served in the Dutch East Indies in 1930 and at Balik-Papan, Borneo from 1932 to 1940.

Morris Miller Slotnick, 54, died May 7 while on a business trip to Dallas, Texas. A geophysical consultant with Standard-Vacuum Oil Company and widely known in the petroleum industry as research mathematician and geophysical interpreter, he originated and developed many of the basic and advanced methods of geophysical interpretation. One of these is known as the Slotnick Method of computing refraction data.

William Lawrence Green, 55, assistant secretary, Standard Oil Company of California, died May 12 in San Francisco. Joining Standard of California as a hall boy in 1919, he later served in the Tax and Insurance department, the Secretary's office and in the Industrial Relations and Personnel departments. He was elected assistant secretary in 1947.

Robert Frazier Garland, 65, discoverer of the Seminole pool and prominent in oil and aviation circles, died May 26 in La Jolla, Calif.

Morton T. Higgs, 60, died in Los Angeles June 4. Long prominent in the oil business, he was with Lane-Wells Company 17 years. He resigned as vice president in charge of operations and sales in 1955. Prior to joining Lane-Wells, he did geology work in the West Indies, Panama, Ecuador, Texas, Kansas and Oklahoma.

W. D. Shirley, early Kern County oil man, died recently in Bakersfield, Calif. He had been in the oil business 51 years and was one of the first men in the Tejon field near Lebec.

Charles O. Weaver, 88, retired Gulf Oil Corporation driller, died April 23 in Sapulpa, Okla. Moving to Oklahoma before statehood, he drilled a number of wells in the Dewey, Bartlesville, Copan and Ramona areas before moving to Creek County. He joined Gulf in the Glenpool in 1912 and retired in 1928.

George Hamlin Shaw, 65, director and vice president of Cities Service Company, died April 24 while attending the company's annual meeting at Dover, Del. He joined the company in 1933. In 1936 he was made a director, and in January this year, a vice president. He also was industrial relations counsel of Cities Service Petroleum, Inc., and a director of Atlas Corporation.

G. F. Gephart, 57, died in San Francico April 24. Joining Pacific Gasoline Company in 1922, four years before it became a part of Standard Oil Company of California, he had served as comptroller of Standard of California since 1944.

Lester H. Keim, former vice president of Oilwell Supply Company and most recently consultant on labor relations at Byron Jackson Division of Borg Warner Corporation, died recently in Los Angeles. He had been active in the Los Angeles oil industry since 1924.

Pierce Larkin, 78, formerly chief geologist for the Gilcrease Oil Company, died April 20 in Tulsa. He was one of four men associated with Thomas Gilcrease in the development of the company, joining the firm in 1918.

Lee I. Lough, 93, field superintendent for the former Mac Thwaite Oil and Gas Company at Ada, Okla., died in Drumright April 22. He had retired in 1927.

Clinton A. Solt, 63, former treasurer of the Valley Osage Oil Company in Tulsa, died April 20. He was treasurer of the oil firm many years before moving to San Antonio in 1943 to accept a position with Gilcrease Oil Company.

Lawrence D. Hibbs, 61, died April 20 in Tulsa. Active in the oil business since 1920, he had been an independent oil lease operator in Tulsa the last 15 years.

John Raymond Manion, 80, prominent Tulsa oil man, died April 15. He was a retired vice president of the old Sinclair Refining Company.

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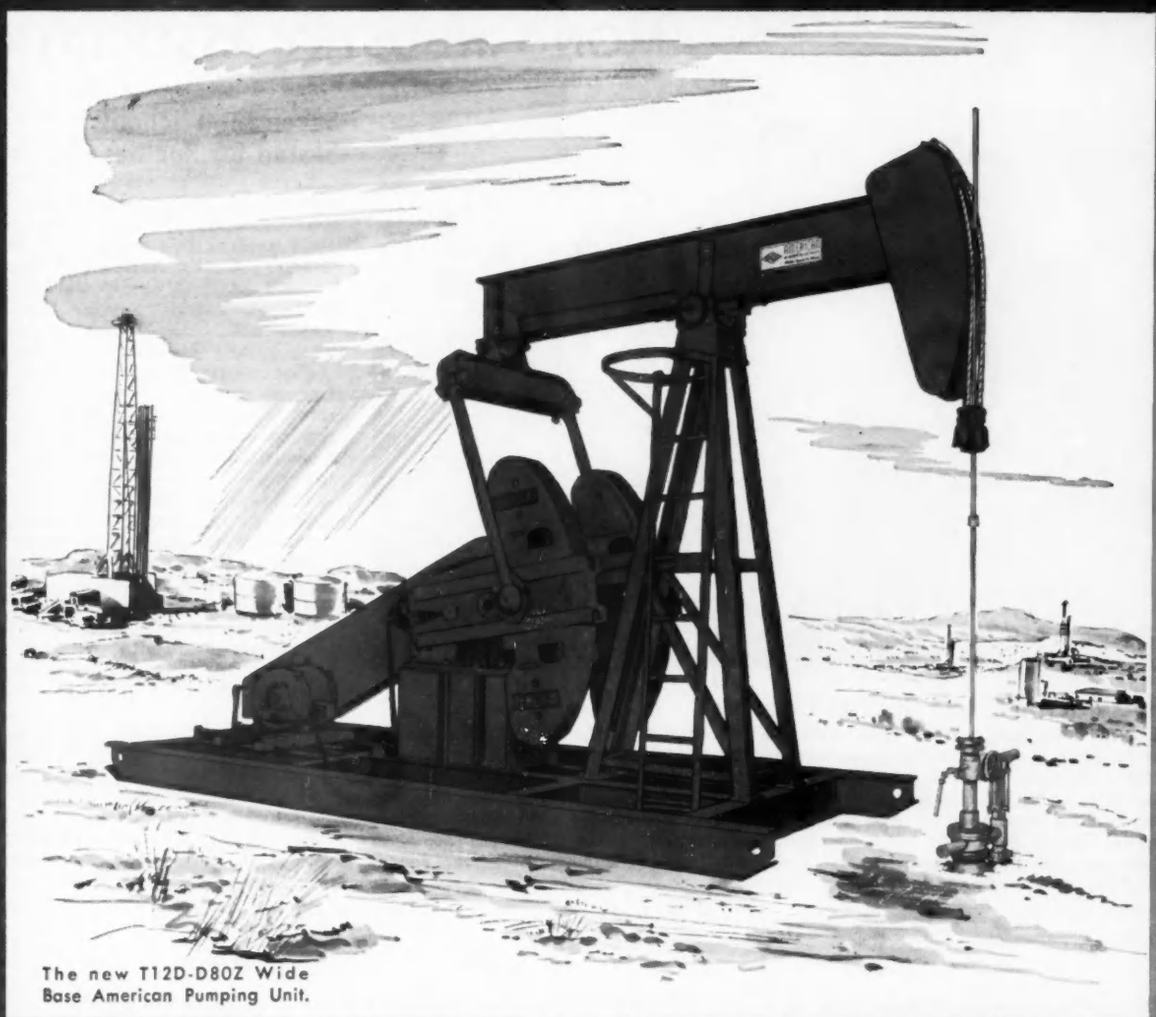

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What's Happening

AMONG INDUSTRY ASSOCIATIONS

API Elects Pacific Coast District Officers

Frank T. Lloyd (first row, center) is the newly-elected chairman of the Pacific Coast District, Division of Production, American Petroleum Institute. He is with Richfield Oil Corporation. On his left is Mrs. Elsie M. Edmiston, district secretary; on his right, Oran A. Graybeal, outgoing district chairman. Other officers include (standing, left to right) O. M. Griffin, vice chairman, Coalinga-Kettleman; Paul Andrews, vice chairman, Advisory Committee; I. M. MacKenzie, Jr., vice chairman, Coastal Area; Charles T. Reichert, treasurer; and Henry G. Abadie, vice chairman, Los Angeles Basin. Not shown are H. D. Campbell, vice chairman of the San Joaquin Valley, and John Bell, chairman of the Advisory Committee.

Seven Mud Schools Slated for Rockies

Seven summer mud schools are scheduled for drilling engineers and field personnel in the Rocky Mountain region. Held under the auspices of the Casper chapter of the American Association of Oilwell Drilling Contractors, the schools are co-sponsored by the University of Texas and State Vocational Training agencies of Wyoming and Montana.

The course, designed as a refresher for trained engineers and an introduction to mud control for roustabouts, derrick men, drillers and farm bosses, consists of lecture periods, laboratory tests and experimentation.

Odys Simmons and James Conway, specialists in petroleum training with the Petroleum Extension Service of the University of Texas, will conduct the schools. New techniques in handling mud will keynote the training program.

The new series, which began May 14 in Greybull, Mont., will be completed August 20 in Tioga, N. D. The complete schedule is: May 14, Greybull, Mont.; May 28, Cody, Wyo.; June 11, Thermopolis, Wyo.; July 9, Casper, Wyo.; July 23, Billings, Mont.; August 6, Rock Springs, Wyo.; and August 20, Tioga, N. D.

Ray Sing, Bighorn Drilling Company, 119 Beach Street, Casper, serves as chairman for the Education Committee of the AAODC Casper chapter and has arranged the schools.

for acidizing or fracturing...
the toughest blocking agent is
Formjel

New Educational Council Named to Advise OIIC

Creation of an Educational Advisory Council to work with the Oil Industry Information Committee and its nationwide school program was announced recently by OIIC Executive Director H. B. Miller. Specific objective of the council's formation is to broaden the school program and to provide OIIC with specialized counsel and guidance.

The council consists of 14 persons appointed by Frank M. Porter, president of the American Petroleum Institute. Members are educational specialists on the staff of oil companies throughout the country.

Scope of the council's operation is: 1) to advise and consult with OIIC educational supervisor and make recommendations for more effective implementation and administration of the school program approved by the National OIIC; 2) to advise the supervisor regarding specific problems or activities in connection with the program which are referred to the group; 3) to recommend proposals for more effective coordination of the OIIC school program with similar programs conducted by oil companies and other petroleum industry trade associations; 4) to serve as a clearing house for exchange of information regarding development, distribution and use of business-sponsored teaching aids and educational material; 5) to review periodically with the OIIC supervisor the progress of the program and to evaluate its effectiveness for report to the Education and Youth Subcommittee of the National OIIC; and 6) to make recommendations to the Education Subcommittee for changes in the OIIC school program or in the policies established for its administration.

C. Drew Stahl

C. V. Kirkpatrick

C. E. Murphy

Frank G. Miller

AAODC Presents Awards To Outstanding Educators

J. Paul Roston

Five educators from accredited schools of engineering have been saluted by the American Association of Oilwell Drilling Contractors for their work in developing and training young engineers for the drilling industry.

The 1956 Honorariums went to: Professor Paul Roston, Missouri School of Mines & Metallurgy; C. Drew Stahl, The Pennsylvania State University; Professor C. V. Kirkpatrick, The University of Houston; C. E. Murphy, The Texas College of Arts and Industries; and Professor Frank G. Miller, Stanford University.

In campus ceremonies, directors and officers of the AAODC presented the Association's checks and award plaques to the recipients for their outstanding efforts to perpetuate the idea of drilling careers.

The Honorariums, established in 1953, have gone to professors in 16 of the 19 accredited schools of petroleum engineering in the nation.

California ASME Sponsors Management Training Class

Two new classes in the engineering-management training courses for the Los Angeles area were begun in May by the American Society of Mechanical Engineers' Management Division of Southern California. William C. Urlovic, consultant in management engineering at Floyd Graham & Associates, is conducting the courses.

The two-year training program, which began last fall, has been attended by representatives of 45 companies.

The classes work through case-history studies, role-playing and small problem-solving groups. Discussion of actual own-problems in work situations also are discussed.

Successful treatment in either limestone or sandstone formations frequently depends upon effective blocking. *Formjel* is a temporary sealing or blocking material we use to control acidizing and hydraulic fracturing treatments. It is compounded with kerosene, a jelling agent, a breaker, and a filler. It has excellent viscosity, A.P.I. fluid loss is zero, the weight may be varied, and the material is formulated so that it will break out completely within 10 to 24 hours. The widespread success of Formjel in thousands of wells has established it as the toughest blocking agent in the oil field today.

Using The Chemical Process Company Permeter Control Tools, a slug of Formjel can be spotted to block an upper zone while the lower zone is being treated (and vice versa), to block channeling behind casing set through pay zones, to seal leaking packers or block the formation above or below a packer against vertical communication, or to achieve multiple zone penetration.

Two companion blocking agents are also available for special well conditions: *Thermogel,* for wells with high bottom hole temperatures, has excellent stability and maintains its viscosity during prolonged treatment of deep wells. *Firmjel,* a special, permanent-type seal, is designed for correcting gas-oil ratios by sealing the gas pay above a packer. We have used both of these agents successfully in hundreds of wells.

If you are encountering unusual engineering problems in acidizing or fracturing your wells, contact your nearest Chemical Process Company station for more information about these and other special CPC well stimulation procedures. There is no obligation, and you will find our representatives anxious to help you any way they can.

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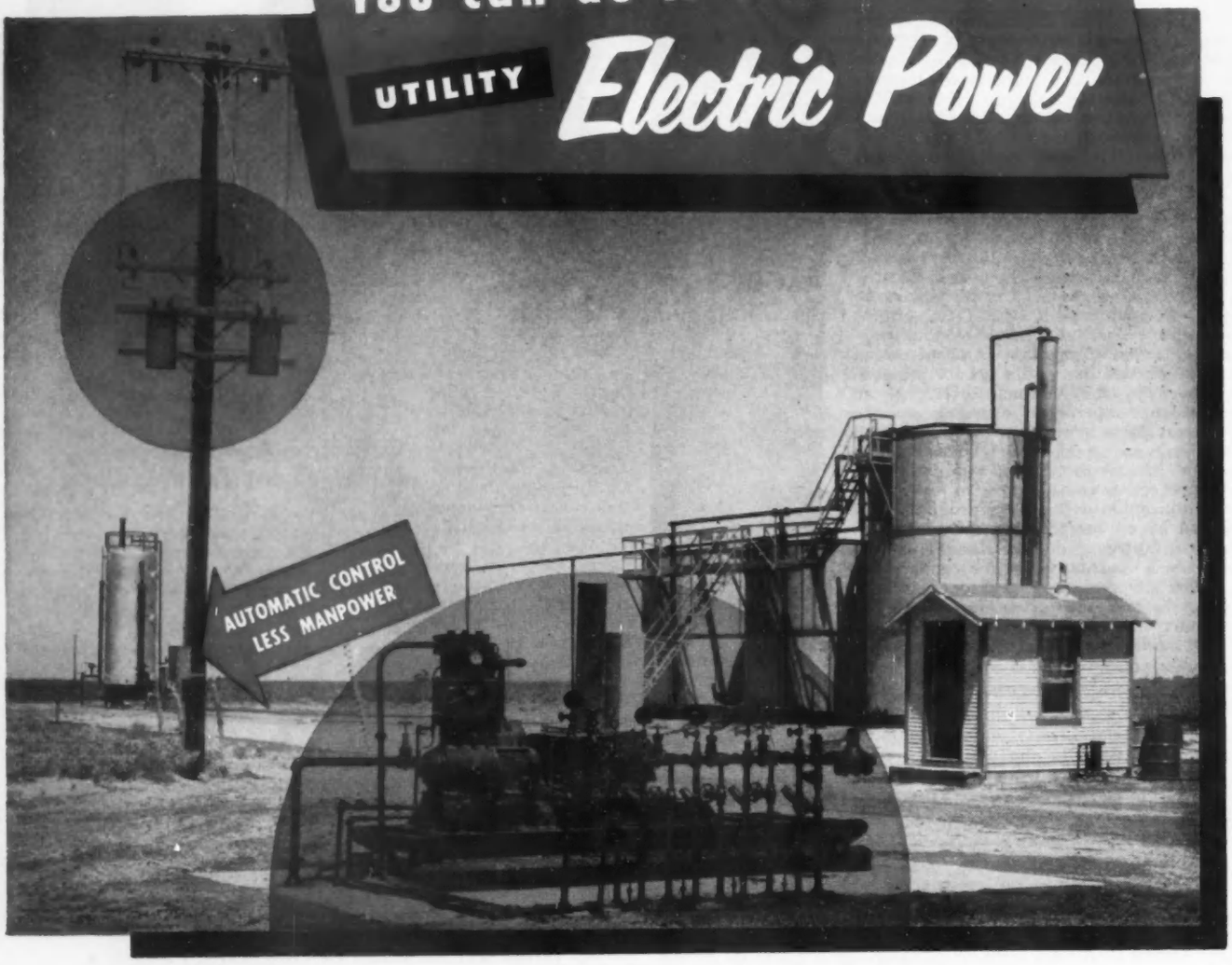

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Past Presidents Attend Meeting

Past presidents of the Los Angeles Chapter of Nomads attending a recent meeting included (left to right, standing) Henry Pullman, Baker Oil Tools, 1943; Bob Eiche, R. J. Eiche and Associates, 1947; Bill Wilson, Web Wilson Oil Tools, Inc., 1952; and Joe Schlarb, Emsco Manufacturing Company, 1954. Seated are Ted Sutter, Baker Oil Tools, 1940; Elmer Decker, Martin-Decker Corporation, first president, 1939; Harry Hester, McCullough Tool Company, current president; and Ernie Fowks, Emsco, 1941. Not shown is Roland Smith, Roland E. Smith Company, 1944.

Eastern API District Elects Rogers Chairman

The Eastern District Division of Production of the American Petroleum Institute have elected Douglas Rogers, Jr., of the South Penn Oil Company, district chairman to serve through the 1957 spring meeting.

Vice chairmen elected to serve with him were: H. T. Heuple, Manufacturers Light & Heat Company; J. Robert Hornor, Delaware Gas Company; Wendell Moore, Columbian Carbon Company; Lysle Kirk, Ohio Fuel Gas Company; L. T. Evans, East Ohio Gas Company; Millard Flood, The Ohio Oil Company; Dean Russell, Gordon Drilling Company; and John C. Hall, Standard Oil Company (Ohio).

Secretary-treasurer for the year will be H. J. Magner, of the Delta Drilling Company. Outgoing district chairman, Jack Cashell, Preston Oil Company, was named chairman of the Advisory Committee.

More than 400 oil production men from the Eastern states gathered to discuss oil and gas production at the meeting recently held in Columbus, Ohio.

Five Citations for Service awards and two Meritorious Service Awards were presented to seven oil men for outstanding service to the oil industry at the opening session of the district meeting.

Recipients were E. H. Tollefson, Hope Natural Gas Company, Clarksburg, W. Va.; R. L. Bird, Jr., Columbian Carbon Company, Charleston, W. Va.; W. H. Young, Jr., Bradley Producing Company, Wellsville, N. Y.; M. G. Gulley, Gulf Oil Corporation, Pittsburgh; and L. N. Winkler, Bethlehem Steel Company, Bethlehem, Penn.

J. P. Bassett, special assistant to division manager, Sun Oil Company, Evansville, Ind., and O. L. Martin, production manager of Turner Petroleum Company and Michigan Oil Company, Mt. Pleasant, Mich., also received awards.

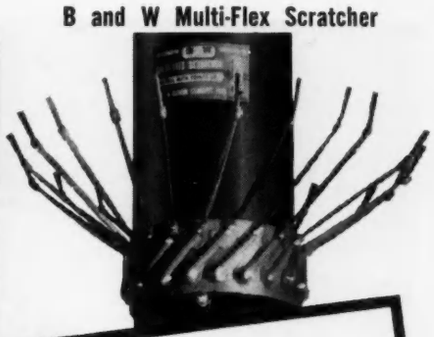
Fifty-First NACE Section Organized at Great Bend

The fifty-first local section of the National Association of Corrosion Engineers received its charter recently at Great Bend, Kan. It is known as the West Kansas Section. Thomas A. Allan, Cooperative Refinery Association, Great Bend, is chairman. Other officers are Dewey L. Peterson, Jr., Cities Service Oil Company, vice chairman; Jack P. Berry, National Aluminate Company, Hutchinson, Kan., secretary treasurer.

International Guests Attend Houston Meeting

This group includes four of the international guests attending a recent meeting of the Houston Chapter of Nomads. From left to right are G. A. Standish, drilling superintendent, Colombian Petroleum Corporation, Cucuta, Colombia; D. G. Hanwell, petroleum engineer, Iraq Petroleum Company, Ltd., Basrah, Iraq; H. G. Lindley, STOCA Drilling Company, Caracas, Venezuela; and Luis Moran, petroleum engineer for Petroleos Mexicanos, Mexico City.

B and W Multi-Flex Scratcher



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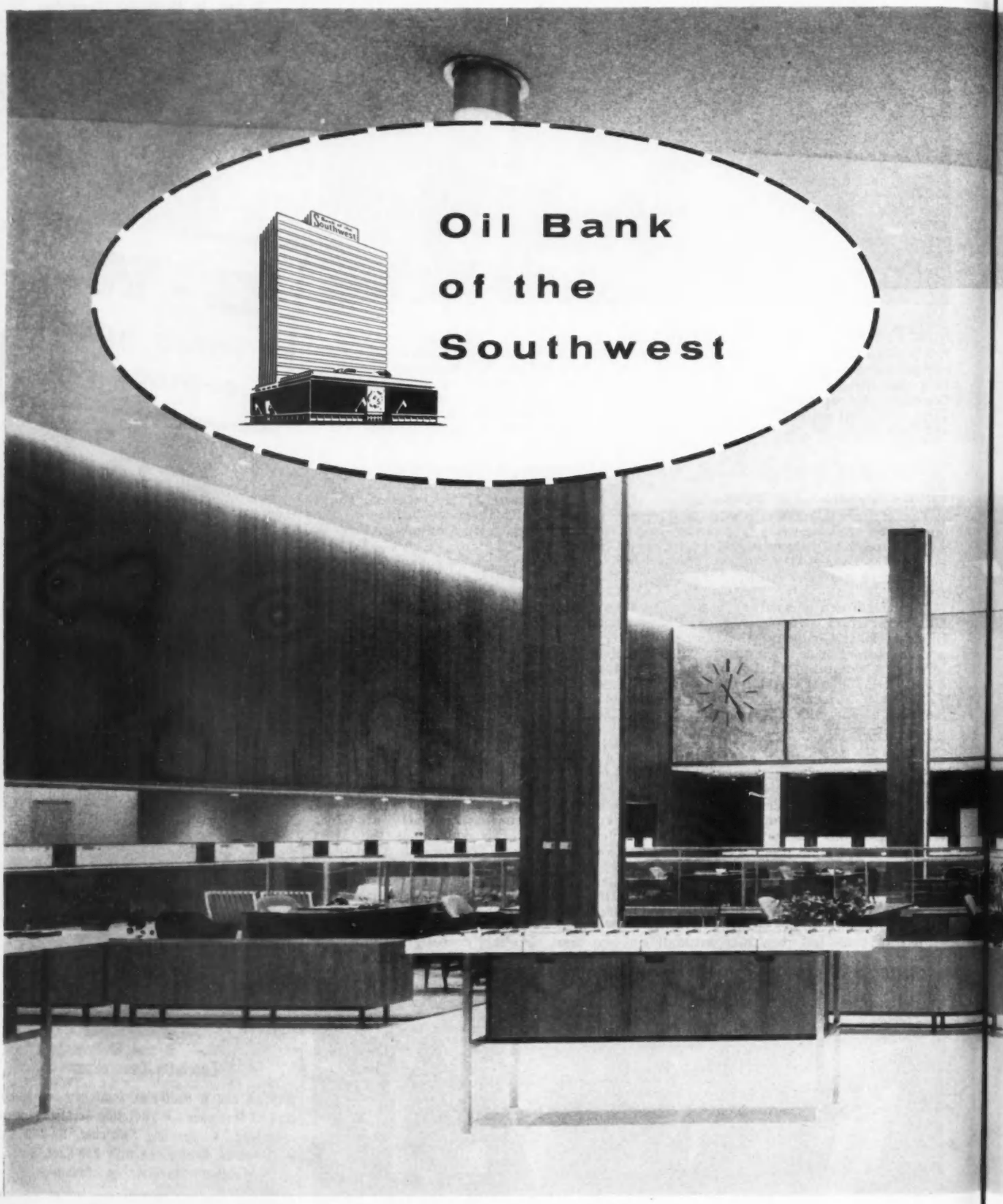

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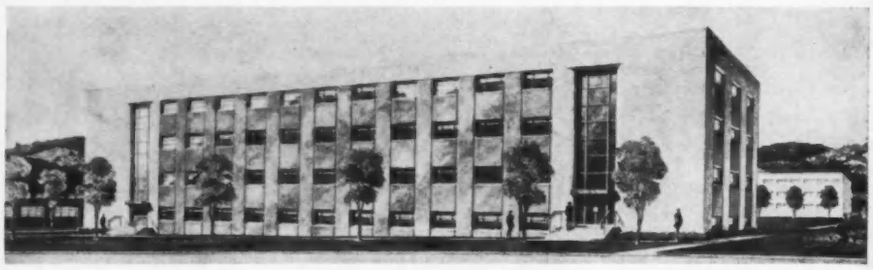
Companies in the News

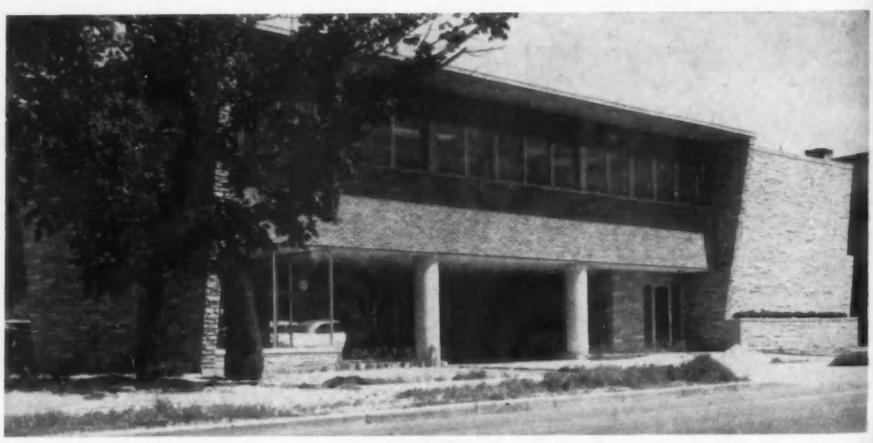


Architect's drawing of larger of two laboratories which will house expanded research into oil production at Gulf Research & Development Company, Harmarville, Penn. The four-story building will include some 94 laboratories and offices, besides storage, utility and service rooms.

GULF RESEARCH & DEVELOPMENT COMPANY has undertaken an expanded production research program to be conducted by 150 scientists, engineers and technicians in an effort to improve recovery of petroleum from oil fields. Specific aims include increasing percentage of petroleum recovered from oil formations, and bettering both speed and economy of drilling wells, producing and transporting oil and gas. Two new buildings, to cost approximately $1½ million, will house these activities. The smaller, for heavy drilling research, is scheduled for completion in August, and the main building, in January, 1957. **R. A. Morse,** associate director of research, will coordinate the work which will be performed by the Production Engineering and Reservoir Mechanics divisions. Reservoir Mechanics will concentrate on improving over-all recovery from oil fields. Production Engineering will seek to improve drilling of wells and utilization of pipe lines; research on offshore drilling and production problems also will be in its province.

SHELL COMPANIES FOUNDATION, INC., recently announced that it will contribute more than $1 million this year to educational, charitable, religious and public service organizations. The amount is allocated from gifts made to the Foundation by the Shell companies. Approximately $450,000 of the million dollars is provided for educational programs, an increase of $100,000 over 1955. Shell will provide 50 graduate fellowships and 20 grants for fundamental research to 42 colleges and universities throughout the nation. It also is inaugrating a new program to help overcome the shortage of engineers and scientists—Merit Fellowship seminars at Cornell University and Stanford University for 60 outstanding high school science and mathematics teachers. Other schools and educational programs will receive support through Shell gifts to the National Fund for Medical Education, the National Science Teachers Association, the Council for Advancement of Secondary Education, the Institute of International Education, Inc., and the United Negro College Fund, Inc.

THE NATIONAL SAFETY COUNCIL has awarded its 1955 Public Interest Award to six petroleum companies. The advertising campaigns of American Oil Company, Esso Standard Oil Company, Ethyl Corporation, Humble Oil & Refining Company, Imperial Oil Ltd., and Standard Oil Company (Indiana) were cited by the Council for exceptional service to safety in 1955.



Denver Consultants Move into New Building

Doeringsfeld, Amuedo and Ivey, consulting geologists, recently moved into new quarters at 240 Washington Street, Denver. Specializing in domestic and foreign photogeologic evaluations and in areal geologic studies, the firm was organized in 1953 by Walter W. Doeringsfeld, Curtis L. Amuedo and John B. Ivey. It now employs 18 geologists, draftsmen, and photogrammetrists. A recent affiliation with Abrams Aerial Surveys provides D. A. I. with expanded photogrammetric engineering and flying services.

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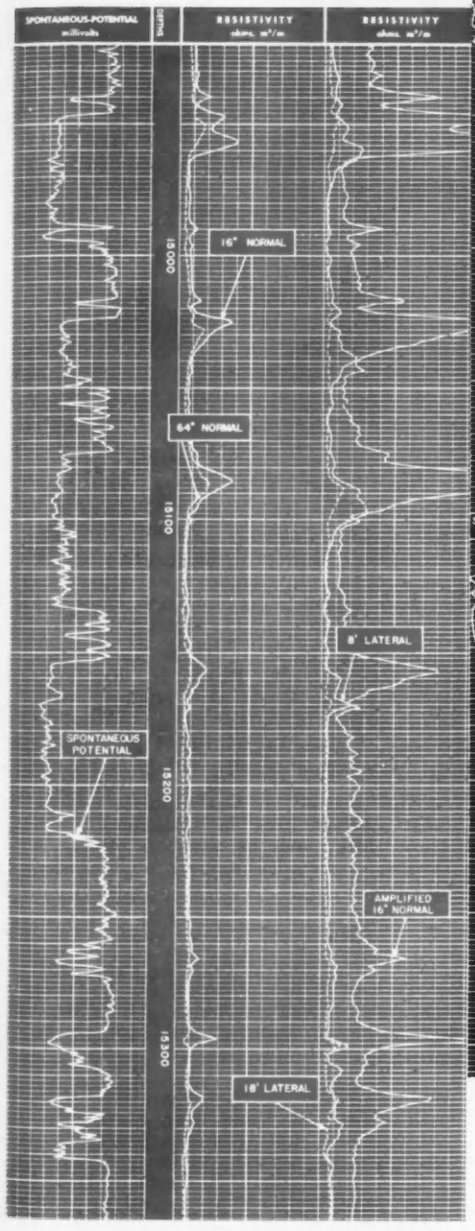
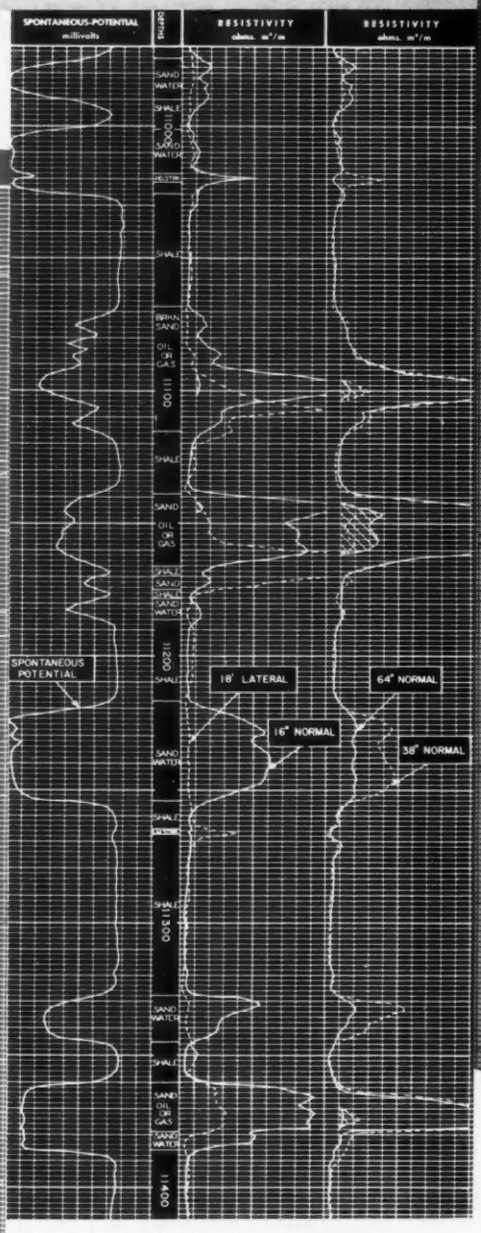
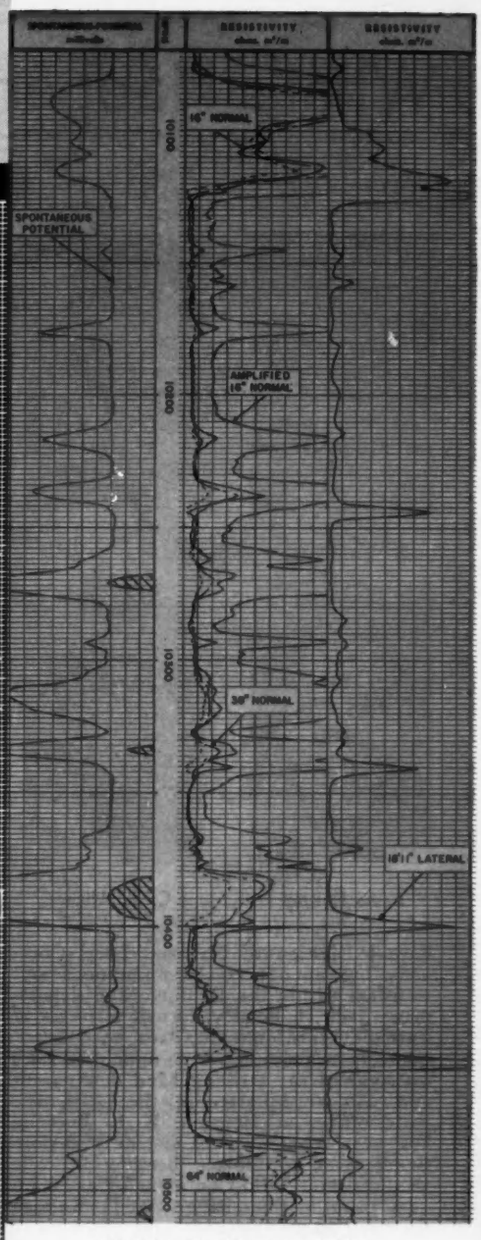


PGAC Electrical Log, Type P-2N-2L
For Gulf Coast Formations



PGAC Electrical Log, Type P-NL-2N
For Oklahoma Formations



PGAC Electrical Log, Type P-3N-L
For Venezuela Formations

CODE TO LOG TYPES:
P—Spontaneous Potential
N—Normal Curve
L—Lateral Curve

Whatever you need in **ELECTRICAL LOGS!**

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4 RESISTIVITY CURVES and 1 S.P. = 5 Curves for more data
PLUS 1 Amplified Normal Curve placed where you want it—**and all recorded simultaneously**

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What's Happening

AMONG SERVICE AND SUPPLY MEN

Jack H. Beesley

B. L. Boccella

W. C. Kellogg

W. A. Henslee

Harry C. Loehr

H. I. Bussa

P. A. Newton

C. D. Allen

Ed L. Easley

J. H. Dunaway

H. C. Leland

O. A. Hicks

Baroid Division of National Lead Company has announced 16 promotions and transfers within the Drilling Mud department. **Jack H. Beesley,** former manager of Baroid's Mid-Continent Area with headquarters in Tulsa, has been appointed sales manager of the Drilling Mud department and will headquarter in the company's main offices at Houston. **B. L. Boccella** has been appointed manager, Mid-Continent Area to replace Beesley. Boccella was assistant Mid-Continent Area manager prior to this change. **W. C. Kellogg** has been named assistant area manager of the Louisiana Gulf Coast Area with headquarters in New Orleans. He will supervise the area's district superintendents and their respective personnel. Kellogg was superintendent of the South Texas Corpus Christi district and is replaced by **W. A. Henslee,** formerly superintendent of West Texas Odessa district. **Harry C. Loehr, Jr.,** appointed assistant area manager of the Mid-Continent Area with offices in Tulsa, was formerly Louisiana Gulf Coast Area sales manager with headquarters in New Orleans. New Texas Gulf Coast assistant area manager with headquarters in Houston is **H. I. Bussa,** former superintendent of the Northern Oklahoma district with headquarters in Oklahoma City. A new sales office in Lafayette, La., will be headed by **P. A. Newton** who has been named Louisiana Gulf Coast Area sales representative. He was formerly superintendent of the Lafayette district. A new assignment as superintendent of the New Orleans district has been given **F. M. Hill, Jr.,** former New Orleans district sales representative. **C. D. Allen, Jr.,** will take over the duties as Superintendent of West Texas, Odessa district, turning over the North Texas, Sherman district superintendency to **Ed. L. Easley** who has been promoted from service engineer of the Amarillo and Abilene district. His district headquarters will be in Wichita Falls, Texas. **J. H. Dunaway** has been appointed superintendent of the Louisiana Lafayette district and will continue to headquarter in New Iberia, La., where he has been a service engineer. **H. C. Leland,** area engineer in the Midland, Texas, Area office, has been transferred to Dawson Creek, B. C., Canada, where he will take over duties as superintendent of the Northern British Columbia and Northwestern Alberta district. **C. A. Reid,** Pacific Coast Area engineer, will replace Leland as area engineer in the West Texas Area, Midland office. **O. L. Riley, Jr.,** has been named Pacific Coast area engineer with headquarters in Los Angeles. Another change in the Mid-Continent area makes **O. A. Hicks** superintendent of Northern Oklahoma district, with headquarters in Oklahoma City. He was formerly district sales representative in Oklahoma City. Those duties will be assumed by **L. T. Downs,** former sales engineer in Chickasha, Oklahoma.

Raybestos-Manhattan, Inc., has announced the appointment of **Paul Kushubar** and **Wesley Pontier** to the sales engineering staff of chief engineer Guy E. Horvath. Kushubar moves to the Packing division from RM's plant at Bridgeport, Conn., where for five years he has been project engineer working on development and processing procedures of several product groups including compressed asbestos sheet packings. Pontier has been with the Manhattan Rubber division 15 years. Most recently he has been in the industrial engineering department, specializing in production and methods procedure.

Charles L. Holbert is now executive vice president of **H. K. Porter Company, Inc.,** succeeding **Clarence R. Dobson** who has retired. Dobson, who joined Porter in 1946, will serve as a consultant to the company. Holbert, who joined Porter earlier this year as vice president, formerly was executive vice president of the Southern Pacific Milling Company and vice president and general manager of the Johnston Pump Company.

Waukesha Motor Company has announced the appointment of **J. Roger Merriam** as assistant chief engineer. With the company 35 years, he started in 1920 as a tool designer. After several years he transferred to the field of engine design and has been concerned in the development of a number of design features used in most internal combustion engines.

William Whitfield, formerly assistant superintendent of **Lone Star Steel Company's** rolling mills, has been promoted to administrative assistant to the general superintendent of the E. B. Germany Works. Succeeding Whitfield at the rolling mills is **Jeremiah Sheehan** who was promoted from shift foreman. Whitfield joined Lone Star three years ago, moving from Republic Steel where he served as shift foreman until his promotion to assistant superintendent in 1954. Sheehan, who has been with the company three years, formerly was heater helper and shift foreman with Crucible Steel Company of Midland, Penn.

L. Glenn Rader has been appointed vice president and general manager of sales for **Maloney-Crawford Tank and Manufacturing Company** of Tulsa. Former division manager at Houston, he will make his headquarters in Tulsa. **C. B. (Clint) Warren** of Houston has been elevated to the Maloney-Crawford division managership at Houston.

Floyd A. Enz

James B. Graves

Glyn D. Norwood

Val L. Forsyth

Floyd A. Enz has been named vice president and secretary-treasurer of **Magnet Cove Barium Corporation; James B. Graves** has been named controller to succeed him. Enz has had extensive experience in corporation finance and accounting. After 15 years with the building products industry, he joined Magcobar in 1945. He worked a year at the Malvern, Ark., barite plant before transferring to Houston. In 1946 he was named controller of the corporation. Graves for three years was with the C.P.A. firm of Frazer and Torbet in Houston as senior accountant, becoming staff accountant with Magcobar in 1951. In 1954 he was named manager of the accounting division.

Glyn D. Norwood has been appointed sales and service engineer for **Weatherford Oil Tool Company** in the North Texas area. Formerly with Norwood Drilling Company from 1939 to 1955 as roughneck, driller and toolpusher, he formed the Norwood Well Service Company in 1955 which he owned and operated before joining Weatherford.

Val L. Forsyth, formerly chief engineer and more recently technical assistant to the president, is now manager of manufacturing, engineering and purchasing of **Lane-Wells Company,** one of the Dresser Industries. Joining the company as a rigman in 1938, Forsyth advanced through Mid-Continent and field service engineering to become Lane-Wells chief engineer in 1952. He will have charge of all engineering, purchasing and manufacturing activities of the company's Los Angeles plant.

Lear Electronic GmbH, subsidiary of Lear, Inc., has named **Hermann T. Poeschl** manager. The German operating company is located at Riem near Munich. Poeschl joined Askania-Werke AG, Berlin, in 1937 where he worked in flight test and autopilot development. He became Askania's chief design engineer, and later was appointed division technical manager of the Munich division. He joined Karl Frank GmbH in Weinheim in 1954, serving as technical director of the company.

"...thinks he's the core catcher."

There's no catching up with the demand for oil. That's the reason Lone Star Steel Company crews work day and night . . turning out API casing, tubing and line pipe for our friends in the oil business in the busy Mid-Continent area.

Lone Star pipe mills operate a never-slackening schedule for the personal convenience of Joe Roughneck, heart of the oil industry. Joe symbolizes the colorful, rugged individualists . . in the field and heading companies . . who have made the petroleum industry great. Lone Star is Joe's close-at-hand API pipe supplier.

Neighbor, wherever you are, specify Lone Star . . and we both get a good deal.

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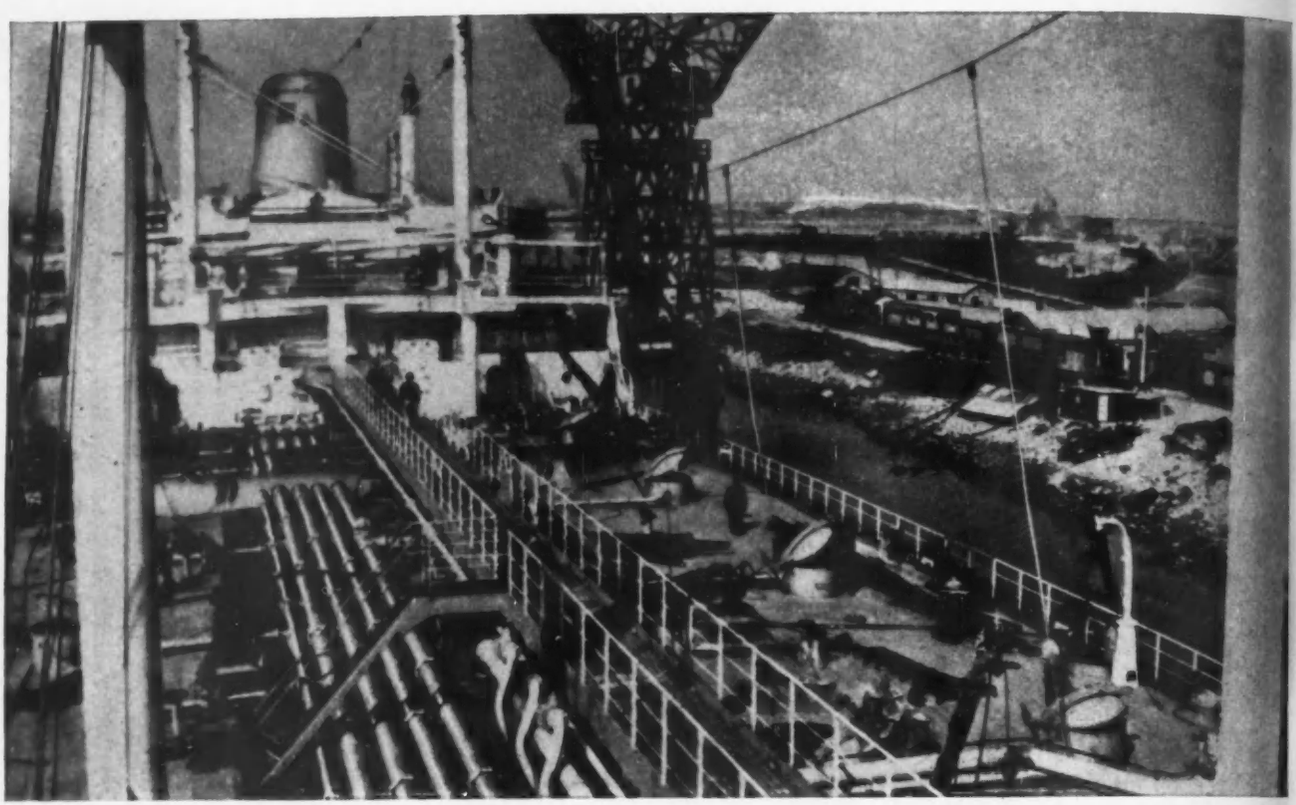
Tulsa, Oklahoma | Wichita Falls, Texas | Shreveport, La.



French tanker *DeBaif*, one of many vessels now equipped with filling pipe cast by one of the world's largest producers of ductile iron, the Pont-à-Mousson Co. of Nancy, France. The company's U.S.A. correspondent is Pontex Pipe Corp., 116 John Street, New York 38, N. Y.

30 tankers now use Ductile Iron pipe... resist corrosion, cut weight, add safety

Relatively new in this country, petroleum pipe of ductile cast iron provides a combination of properties distinctly superior to conventional materials for tanker lines . . .

For ductile cast iron pipe combines the corrosion resistance of gray iron, plus a design strength comparable to that of carbon steel pipe.

Overseas, the Pont-à-Mousson Company of France casts ductile iron loading, stripping and reheater pipe for oil tankers. For superior corrosion resistance in petroleum media Pont-à-Mousson uses ductile iron alloyed with approximately 1.50% nickel. Performance on some 30 vessels during the past several years confirms the durability and economy of ductile iron, for pipe wherever petroleum products must be transported.

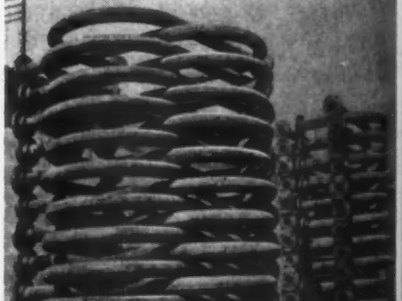
Less corrosion, fewer replacements

In fact, on tankers, this pipe is resistant to corrosion from two different sources. From petroleum cargo, and from sea water ballast on return.

Saves weight, safely

You can cut weight of loading and stripping pipe by specifying ductile cast iron. Its toughness permits walls thinner than those needed in gray iron pipe to withstand mechanical stresses from the ship's motion. You thus substantially reduce deadweight. And you actually increase safety, due to the flexibility and high bursting strength of ductile iron pipe.

Tankers using ductile cast iron pipe now enjoy advantages that are readily available to you. So use this economical material for *your* piping. We'll send you a list of authorized foundries now producing ductile cast iron in the United States. And a Pont-à-Mousson Company booklet describing several applications made by this French organization, with a summary of results. They're yours for the asking... write for them now.



Ductile cast iron heater coils for tanker. Resistance to salt water makes ductile cast iron pipe particularly suited for heater coils. Usually steel coils succumb to corrosion after 2 to 3 years' use. After 3 years, ductile cast iron coils in the same application show no traces of corrosion.

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N. Y.

O. Bliss Williams

Paul Courtney

Park L. Myers

Jack E. Human

W-K-M Manufacturing Company announces the appointment of **O. Bliss Williams** as director of industrial and public relations of the company. Williams previously was assistant to the president of the former Key Company which became part of W-K-M in a recent consolidation. Before his employment with Key, he was with the firm of Booz, Allen and Hamilton, management consultants of Chicago.

Cardwell Manufacturing Company has announced the appointment of **Paul Courtney** as general manager of the oil well drilling and servicing equipment manufacturing firm. Courtney recently resigned as president and director of the George E. Failing Company, a subsidiary of Westinghouse Airbrake Company. Associated with the oil industry for many years, he spent considerable time in foreign operations with Shell Oil Company. In more recent years he has been identified with the oil equipment business, serving as vice president of Emsco Manufacturing Company and president of Unit Rig and Equipment Company prior to his association with Failing.

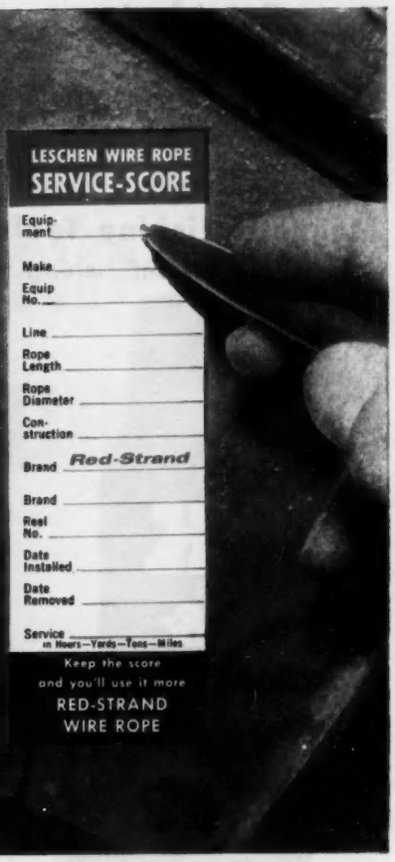
Park L. Myers' promotion to assistant general sales manager of **Hughes Tool Company** has been announced. Formerly sales manager of the North Texas division, he has been with Hughes since 1937 in various capacities in several drilling areas.

Jack E. Human who recently joined the Structural and Galvanizing departments of **Emsco Manufacturing Company** will devote his time also to the sale of Emsco swivel joints. With Associated Piping and Engineering Company five years, he is widely known throughout the oil and steel industries.

William R. Clark, who was chief engineer for **Jones & Laughlin Supply Division**, has been advanced to manager of production-equipment sales. A new position, the job was created to concentrate on the promotion and administration of certain company products, under the General Products Sales division. He has been with the company since 1936.

Now Leschen Offers

NEW WIRE ROPE Service-Score System



Simple plan tests wire rope performance and costs—shows comparative values—helps reduce operating expenses—speeds reordering.

Leschen's quick-fact-finding Service-Score System utilizes easily applied, easily removed pressure sensitive stickers, which record equipment and rope data, dates of rope installation and removal.

What is your *true* wire rope cost? Do you know? Are you using the right rope type or construction? The right brand?

Questions like these are readily answered with Leschen's new Wire Rope Service-Score System. Service-Score stickers report performance—type versus type, brand versus brand. Performance facts reveal costs and help *cut costs.*

Service-Score stickers provide easily-available, *helpful reordering data*—wire rope diameter, length, construction, date installed, and date removed.

Service-Score stickers remind operators when it's time to replace rope—*increasing safety* margins.

Service-Score records enable you to check and compare wire rope types and constructions. For example, you find for yourself, as others have, that Red-Strand consistently scores high. You learn the advantages of super-strength Porter Imperial Red-Strand, or Hercules Flattened Strand.

Write for sample stickers. Or see your nearby Leschen Wire Rope distributor.

LESCHEN Red-Strand WIRE ROPE — A DIVISION OF H. K. PORTER COMPANY, INC. HKP

Keep the score and you'll use it more Red-Strand Wire Rope

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H. K. PORTER COMPANY, INC.
St. Louis 12, Missouri

(For more data on advertised products, use Readers' Service blue cards, last page this issue.)

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William S. Cole

James W. Andrews

B. P. McDonough

Ray E. DeLaMater

William S. Cole and **James W. Andrews, Sr.**, now are district representatives at Beaumont, Texas, for **U. S. Steel's** Oil Well Supply Division. Cole was employed by Oilwell in 1954 as city representative at Houston where he was located prior to his present appointment. Andrews first was employed by the division in 1945 as field engineer at Houston. In 1950 he was appointed district representative at Beaumont and in 1951 became field representative at that location.

Bernard P. McDonough was elected president of **The Parkersburg-Aetna Corporation** recently, succeeding **W. A. Wood** who will continue as a member of the board. McDonough has been a director and chairman of the Executive Committee since November, 1955. **Harry Diamond** of New York City was elected to serve as a director.

Ray E. DeLaMater, who recently resigned as head of the Export department of Franks Division of Cabot Shops, plans to devote full time to his own organization, the **Raydean Company** in Tulsa. In partnership with H. Carroll Morrow, DeLaMater will manage dealer sales of the Raydean Company which distributes electronic equipment and special oil field devices and machinery in a three-state area.

Walker Hamilton has been named as special consultant to the Forest Products division of **Olin Mathieson Chemical Corporation.** Hamilton recently retired as president of Riegel Paper Corporation. He will act as advisor to the Forest Products division for an expansion of its West Monroe, La. facilities.

William F. Gunning has joined the new Data and Control Systems department of **Beckman, Inc.**, as assistant chief project engineer. Also joining the department is **J. Herbert Brown,** who has been responsible for developing a system for performing digital computor operations with magnetic components. Gunning previously was with Douglas Aircraft Company; Brown joined the company some time ago.

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A powerful blend of quick-acting solvents that frees "frozen" parts without breakage. Safe for all metals and alloys.

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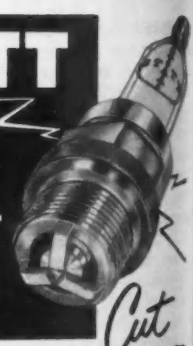
Get them at Industrial or Oil Field Supply Houses.

SOLDER SEAL

RADIATOR SPECIALTY CO.
Charlotte, North Carolina

STITT NEW triple ignitor SPARK PLUGS



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Fully meeting API STD 5A specification, CF&I Oil Country Casing and Tubing are available in sizes from 2⅜" through 9⅝" O.D.

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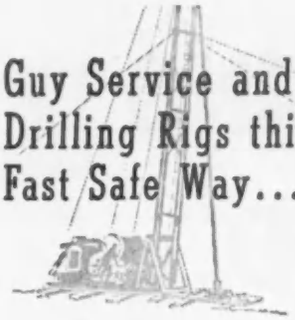
Guy Service and Drilling Rigs this Fast Safe Way...



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CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less downtime, use world famous Miller Sand Pumps.

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Composite Catalog, Page 3369

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Welex Holds Annual Sales Meeting

Fifty-four division managers, assistant division managers, district managers and department heads of Welex Jet Services, Inc. met recently for the company's annual general sales and operations meeting. Reports were given on sales, operations, engineering, accounting procedures, materials and manufacturing, safety, new tools and equipment in design and development, employe benefits and other phases of Welex business. The two-day meeting ended with a tour of Jet Research Center, Inc. facilities.

Carloss Well Supply Company of Memphis, Tenn., is celebrating its 76th anniversary this year.

William Freiden is new sales representative for **Wheeling Machine Products Company,** serving the states of Nebraska and Iowa. Offices will be in Omaha.

Willis E. Jones, newly-appointed sales manager of **The Mercoid Corporation,** will give executive supervision to the general selling activities throughout the corporation. **Paul J. Provost** has been named manager of the company's Industrial Controls division, and **G. R. Folds, Jr.,** has transferred from the West Coast to Chicago to work with Provost in the new division.

Fairbanks, Morse & Co., has announced a number of changes in the factory and sales organization. **L. A. Weom,** who has for the past several years been manager of materials and schedules at the Beloit, Wis., Works, has been appointed manager of the Pump Sales division with headquarters at Kansas City, Kansas. He previously had served the company as salesman, department manager, branch manager, and division manager. **J. R. Walsh,** who has been manager of the company's Kansas City, Kansas Pump Works since its opening, is succeeding Weom at the Beloit Works as manager of materials and schedules. **G. R. Anderson,** who has been manager of the Electrical Works at Freeport, Ill., succeeds Walsh at Kansas City; **A. H. Hoffman,** formerly manager of the company's Westco Pump Works at St. Louis, has been appointed manager of the Freeport Works succeeding Anderson. **V. E. Johnson** has transferred from the Sales division to the Manufacturing division, and has been appointed manager of the Westco Works in St. Louis.

Dr. Carl Frederick Floe, a new director of **Walworth Company,** is professor of metallurgy and Assistant Provost at the Massachusetts Institute of Technology. For many years he has served industry as a consultant particularly in the field of service behavior of metals and surface hardening of steel.

W-K-M Opens New Plant

Looking over new valves in foreground are some of the almost 2000 people who attended dedication ceremonies of the new 12-acre W-K-M Manufacturing Company plant in Missouri City, Texas. Formal opening was held May 17.

Returns from Europe

Lonnie Thompson (right), sales engineer of LeBus International Engineers, Ltd., recently returned from a three-month trip to Europe where he trained engineering and sales personnel of Woodfield Hoist & Associated Industries, Ltd. and Hermann von Rautenkranz-Itag, new sales and service representatives for LeBus counterbalance spooling system. Left is Gordon Fraser, chief sales engineer for Woodfield Hoist. The English and German firms will serve LeBus in Europe, the Middle East and North Africa.

Carl J. Siebert has been selected as sales manager for W-S Fittings Division of **H. K. Porter Company, Inc.** He was district manager of the company's Chicago office. Siebert joined the company in 1952 as sales representative in the Pittsburgh territory. Before that, he was with American Chain & Cable Company and with Westinghouse Corporation.

Wyn McCoy, formerly district manager of **The Timken Roller Bearing Company's** Industrial division in Chicago, has been promoted to division sales-promotion manager at Canton, Ohio. McCoy, who started with the company in 1940, has been manager of the Chicago district since 1952.

John G. Seiler has been elected president of **Tube Turns**, a division of National Cylinder Gas Company. He succeeds **George O. Boomer**, who is retiring. Boomer will continue as chairman of the executive committee of National Cylinder Gas. Seiler, who had been general sales manager since 1945, was elected vice president of the parent company at the same time he was elevated to the presidency of Tube Turns.

Charles W. Glunk has been appointed chief ceramic engineer for **A. P. Green Fire Brick Company, Ltd.**, in Toronto. He was district sales manager in Richmond, Va. Named to replace Glunk as manager at Richmond was **Charles G. Perry**, who had been sales manager of A. P. Green Fire Brick Company of Texas.

Edward N. Bonnett will head a new Pittsburgh sales office established by **Roots-Connersville Blower**, Division of Dresser Industries, Inc. Bonnett, who was assistant sales manager with The Stacey Brothers Gas Construction Company before joining Roots-Connersville in 1955, will assume responsibility for organizing and managing a new sales territory including western Pennsylvania and the northern counties of West Virginia.

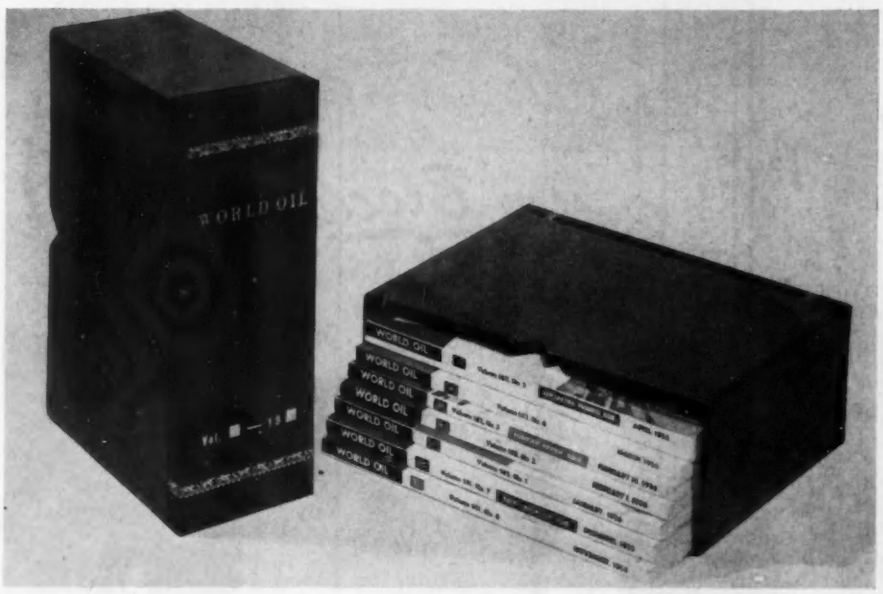
Morey Wilson now is vice president in charge of sales and service with **Ace Mud Service, Ltd.** Headquarters are in Estevan, Saskatchewan, Canada.

Jack Richardson has been appointed southern representative of the **Columbus McKinnon Chain Corporation.** He will handle "CM" industrial chain and kindred products.

Thomas L. Ward's appointment as manager of the **ALCO Products, Inc.**, plant at Dunkirk, N. Y., has been announced. **L. W. Eger**, who has been production manager of thermal products at the Dunkirk plant since last year, has been named to Ward's former post, manager of manufacturing services. Ward has been with ALCO since 1937. Eger joined ALCO the same year at Schenectady where he worked in the materials department.

C. L. Kirkman, recently named manager of domestic sales for **Lane-Wells Company**, one of the Dresser Industries, will have charge of the company's sales activities in the U. S. Formerly division sales manager for Lane-Wells' Mid-Continent division, he joined the company in 1937.

Arnold B. White has been appointed coordinator of engineering standards for **Carrier Corporation.** He will be responsible for standardization activities carried out within the division's Engineering Standards department. White previously was with Veeder-Root, Inc., manufacturer of counting and computing devices.



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Otis Engineering Purchases Bryan Gas Lift Equipment Co.

Otis Engineering Corporation, manufacturing affiliate of Otis Pressure Control, Inc., has announced the purchase of Bryan Gas Lift Equipment Company of Fort Worth. The Fort Worth firm was founded 30 years ago by its president, Thomas E. Bryan, pioneer in the development of gas lift equipment and originator of the idea of retrievable gas lift valves.

Many of the basic patents on gas lift equipment are still held by the company, and much of the equipment is designed to operate with Otis wire line tools for permanent well completions. All patent rights have been purchased by Otis, and plans are to manufacture, market and service the gas lift equipment under the Otis name.

Bryan will act as consultant on future gas lift developments.

Fisher Governor Announces Purchase of Control Specialty

Control Specialty Corporation of Houston has been purchased by Fisher Governor Company of Marshalltown, Iowa. Manufacture of lease automation equipment, tank switches, well testers and other associated products will be continued and expanded at the Houston plant which will operate as a subsidiary of Fisher Governor. Sales and service representation will be available through Fisher representatives.

Fred B. Williams

Kemp E. Barley

Pacific Mud Company Formed on West Coast

J. R. Homan

Organization of Pacific Mud Company, a new firm which will distribute oil well drilling muds in the West Coast area, has been announced by Fred B. Williams, president. The company will operate a number of warehouse stock points throughout California; headquarters have been set up in the National Oil building, Los Angeles. The company will be distributors for the Magnet Cove Barium Corporation, Houston.

Williams has been active in the drilling mud business 17 years. For the past four he has been West Coast district engineer for Sun Ray Oil Company. Kemp E. Barley, vice president, has been associated with oil field service, including drilling mud, 18 years. His experience includes three years with Gulf Oil Company and two years with Halliburton Oil Well Cementing Company in the Mid-Continent area.

J. R. Homan, also vice president, formerly was division sales manager for Magcobar in Los Angeles. He was with the company five years, serving in the Mid-Continent and West Coast areas.

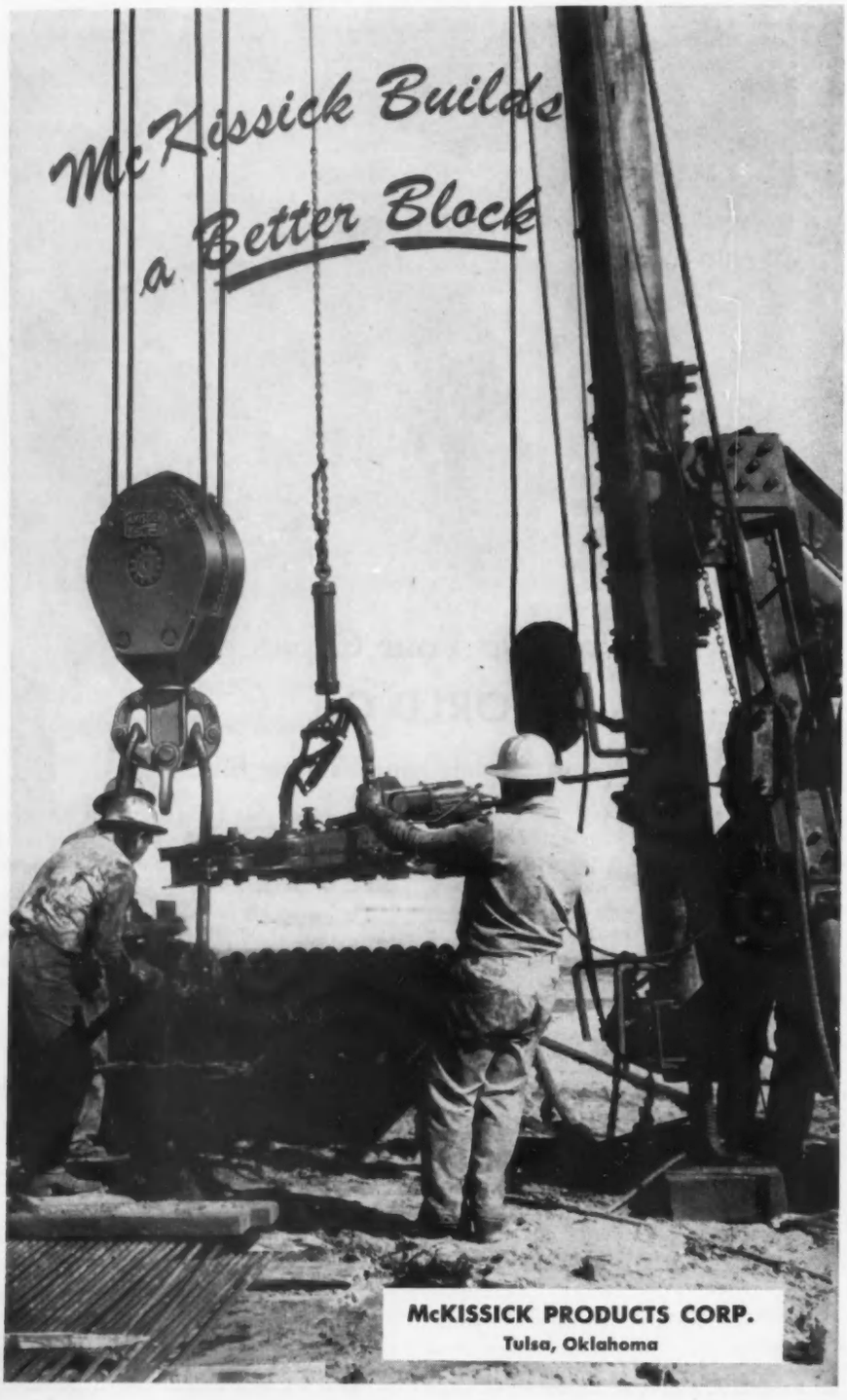
Employes' Children Awarded Schlumberger Scholarships

Children of four Schlumberger employes have been named to receive $500 Conrad and Marcel Schlumberger scholarships. Recipients are chosen by a Scholarship Committee composed of Dr. Rufus Harris, president of Tulane University, Dr. William V. Houston, president of Rice Institute, and E. G. Leonardon, a director of Schlumberger Well Surveying Corporation.

The four are Bob Butler, Ardmore, Okla.; Janet Harter, Magnolia, Ark.; Dennis Phillips, Houston; and Edward Yeargers, Lafayette, La.

In addition, scholarships have been renewed for a second year for the four youths who received the awards last year: Robert Bell, Mt. Carmel, Ill.; Robert Phillips, Los Angeles; Larry Rice, Wichita, Kan.; and Calvin Spencer, Victoria, Texas.

The scholarships are named in memory of the brothers Conrad and Marcel Schlumberger who founded the oil field service firm. Selection for the awards is made on the basis of scholastic record, character, qualities of leadership and seriousness of purpose. Four new scholarships are awarded each year to children of Schlumberger employes.



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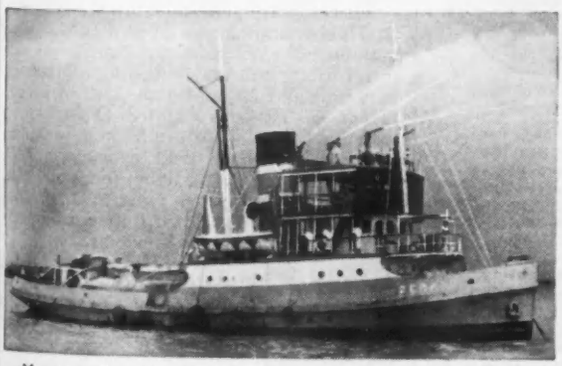
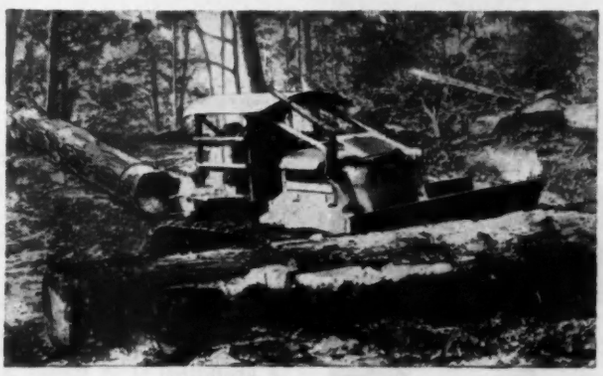
C.P.T. Air Compressor in England

Petbow Generating Set in Baghdad

Scammell Constructor in Kuwait



Merryweather Fire Fighting Equipment in Indian Ocean



V.R.180 Tractor in Tasmania

ROLLS-ROYCE

OIL ENGINES

ROLLS-ROYCE LIMITED, OIL ENGINE DIVISION, DERBY, ENGLAND

Borax Consolidated Plans New American Company

Directors of Borax Consolidated, Limited, have announced in London that they will form a company in the U. S. to take over the greater part of the company's assets and operations in America. Consent of the United Kingdom Treasury to this transfer has been granted.

Completion of transfer of these assets will bring to an American corporation the company's extensive boron deposits at Boron, Calif., and factories for the production of borax, boric acid and numerous inorganic and organic boron compounds.

The directors also have announced that preliminary discussions are taking place with officers of United States Potash Company, in which Borax Consolidated owns substantial stock interest, with a view to the possible merger of the United States Potash Company and the new American company through an exchange of stock. Should the merger be approved, stockholders of the Potash Company would become stockholders of the new American corporation engaged in mining, refining and distribution of the two minerals.

Dewey Supply Sales Office Opened in Oklahoma City

The Dewey Supply Company has announced the opening of an additional sales office in Oklahoma City. R. D. Winans, who has been in the oil field supply business 15 years, has been named sales representative for the new office. The company's headquarters are located in Tulsa with another sales office in Bartlesville, Okla.

Herman Reynolds

Les Hanson

Carl O. Williams

Robert Melton

Grant Oil Tool Expands Mid-Continent Area Facilities

In a further expansion move to increase service facilities in the Mid-Continent and Gulf Coast areas, Grant Oil Tool Company has announced opening of a service branch in Oklahoma City. Named branch manager is Herman Reynolds, who was transferred to his new post from Grant's Hobbs, N. M., branch. He was employed by a drilling contractor several years prior to joining Grant in 1951 as Hobbs branch manager. Assistant branch manager at Oklahoma City is Les Hanson, who was with Western Geophysical Company before joining Grant in 1952.

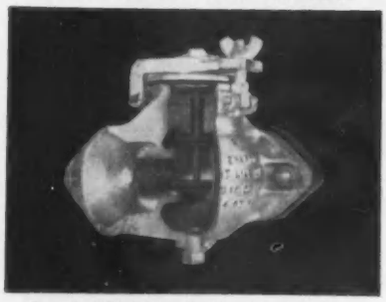
The appointment of Carl O. Williams as Hobbs branch manager also has been announced. Williams previously worked in oil fields with major drilling contractors in Texas and New Mexico. He first joined Grant in 1954. Appointed Odessa salesman by Grant is Robert Melton, who also has had wide oil field experience with major drilling contractors and oil tool manufacturers before joining Grant. As Odessa salesman, he will contact operators throughout the West Texas area.

Avondale Completes Barge For California Company

One of the largest portable, self-stabilizing submersible drilling units built to date has been completed at Avondale Marine Ways, Inc. for The California Company. Recent christening ceremonies were sponsored by Mrs. T. B. Flood, wife of T. B. Flood, vice president and general manager, production, The California Company.

The new Drilling Barge S-55, designed to operate in water depths up to 75 feet and with quarters for 84 men, is 190 feet long, with a height from keel to bottom of superstructure of 90 feet. Latest designs incorporated in the barge include special anti-scouring hull fitted with anti-scouring coaming, bridge crane extending over complete deck extending outboard over starboard and port sides for facilitating material handling. All ballast and fresh water pumps, as well as fresh water and fuel oil, are in the lower hull with generating units; mud pumps and pits on main deck.

Enardo 1900 Series In-Line Vent Valve



Enardo 800 Series In-Line Vent Valve

Are you still looking in the sky for profit losses? Enardo Vent Valves provide a means of keeping a predetermined pressure on stock tanks. These vent valves are used in conjunction with Enardo pressure type hatches. Set 2 to 4 ounces less than hatch pressure to prevent hatch venting.

On leases not using a positive venting system, that have changed to an Enardo Vapor Control System, it has been proven that there was an immediate increase in saleable fluid gravity. For, on a lease with a production of 50 barrels per day, it is possible to add a total savings of $1,482.00 in the books after the installation of proper hatches and vent valves, cutting gravity and volume loss.

Enardo 800 series Vent Valves are offerred in standard 2", 3" and 4" pipe sizes, pressure settings ½ to 16 ounces. Featuring aluminum or semi-steel bodies with plastic trim. Slip-On or flanged ends. Standard valve is 1 ounce pressure, 4/10 ounce vacuum.

Enardo 1900 series Vent Valves also offered in 2", 3" and 4" sizes, with or without companion flanges bolted on. Standard valve 2 ounce pressure, 4/10 ounce vacuum. Pressure settings from 2 to 24 ounces.

Contact the representative nearest you for further information.

Jack Merrill	Harry Higginbotham
Henderson, Texas	Tulsa, Oklahoma
W. R. Lee	K. S. Drane
Midland, Texas	Houston, Texas
Jack D. Neff	Bruce Heller
Ellinwood, Kansas	Tulsa, Oklahoma

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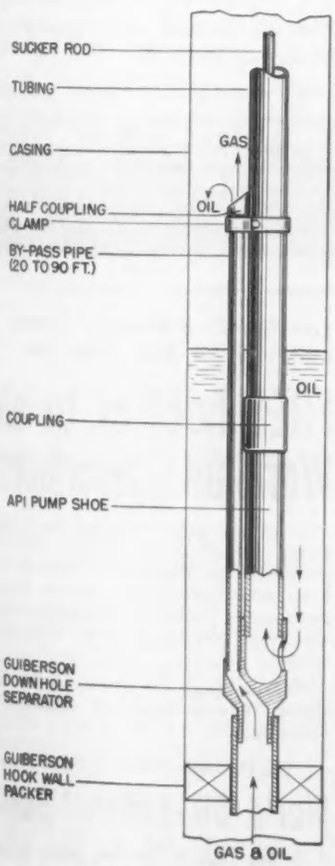
DOWN HOLE SEPARATOR

for pumping wells

Down Hole Separator

The Guiberson down hole separator increases production and eliminates the problem of gas locks, etc., in pumping wells where the produced fluid has a high gas/oil ratio. Less than a foot in length, the separator is screwed directly into a Guiberson packer and the pump shoe fitted directly onto the separator. One to four joints of by-pass pipe, depending upon the producing characteristics of the well, are screwed into the separator and clamped to the tubing. Attached to the top of the by-pass pipe is a half-coupling cut on a diagonal which guides the unit past casing joints. By-pass pipe hugs the tubing as snugly as couplings permit. Production crosses over from the tubing below the packer into the annulus above it and is carried well above the pump shoe by the by-pass pipe. The large annulus above the packer allows the gas to break out of solution and the oil drops back to the large reservoir above the packer where it is picked up by the pump, comparatively free of gas. The separated gas is bled off of the casing continuously. Intake ports on the separator have a larger by-pass area than the tubing. The separator is precision machined from cast steel.



Schematic Installation

ENGINEERING DATA

Part Number	Minimum Casing O.D.	Tubing Size And By-Pass	Maximum Metal O.D.	Approximate Weight	Approximate Length
29439	4½"	2" x ½"	3¾"	12#	13¾"
29133	5"	2" x ½"	4⅛"	14#	10½"
28369	5½"	2" x ¾"	4½"	15#	10⅜"
28645	5½"	2" x 1"	4½"	15#	10⅜"
29606	5½"	2½" x ¾"	4½"	15#	16"
28370	7"	2½" x 1"	5⅝"	20#	11⅛"

Note: The 4½" x 2" and 5½" x 2½" sizes have NUE 10 round top and EUE 8 round bottom field connections; all other sizes are EUE 8 round both ends. When ordering specify part number, casing, tubing and by-pass size.

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Canadian Meter Company Opens New Plant

Officials of both Canadian Meter Company Ltd. and its parent company, American Meter, were hosts at the formal dedication of Canadian Meter's new manufacturing plant in Milton, Ontario, Canada, which is designed to manufacture displacement gas meters and other measurement and control equipment. Shown at the office entrance of the new plant are (front row, left to right) P. W. Geldard, president Canadian Gas Association; A. McBeath, controller, American Meter Company, and J. W. Ostler, general manager, Canadian Meter Company. Back row, left to right, are W. H. Dalton, general manager, Canadian Gas Association; W. L. Ashby, secretary, W. G. Hamilton, Jr., president, and C. B. Dushane, Jr., vice president-sales, American Meter Company.

Shaffer Tool Works Acquires New Shop in Avenal, Calif.

Shaffer Tool Works of Brea, Calif., has purchased a larger office and warehouse building in Avenal, Calif. Located at 950 Skyline Avenue, the office and warehouse building covers 7000 square feet on an industrial site of approximately two acres.

Shaffer Tool Works has maintained warehouse stocks as well as service representation in the Kettleman Hills and Coalinga oil areas since 1931. Official and formal opening of the new Avenal plant was held June 8.

Oil Field Specialty Firms Merge in Rocky Mountain Area

James E. Emrick and James A. Hill announce formation of a general partnership under the name Emrick & Hill Engine & Equipment Company. This new company combines the James A. Hill Company and the James E. Emrick Company, both firms having operated oil field speciality businesses in the Rocky Mountain area for the past several years.

In addition, The Emrick & Hill Engine & Equipment Company announces purchase of Gehring Equipment Company, which has been in business in the Rocky Mountains since 1944. Its principal line has been sales and servicing of Le Roi engines and affiliated products in the entire Rocky Mountain region.

Emrick, before going into business in Casper, Wyo., was with Union Oil Company and Republic Steel Corporation in California many years. Hill spent 17 years with the Oil Well Supply Company before forming the James A. Hill Company in 1952.

Home office of the new company will be in Casper, Wyo., former headquarters of Gehring Equipment Company. Parts stations will be continued at Williston, N. D., Newcastle, Wyo., and Rangely, Colo., with a new sales and service point to be opened in Denver with Emrick in charge.

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Bank Vice President Nye To Head Oil and Gas Division

Consolidation of the First and City National Banks into the First City National Bank of Houston has created one of the Southwest's largest staffs for handling oil and gas financing.

George L. Nye

The oil and gas division, headed by engineer and geologist George L. Nye, also includes two vice presidents and two assistant vice presidents. It is the largest department in the First City National Bank, and the largest oil and gas division in Houston.

Nye was elected one of six senior vice presidents when the banks were consolidated March 30. The vice presidents are A. G. Gueymard and Ed M. Reed; assistant vice presidents are W. E. Bridgforth and P. W. Cawthon, Jr.

Nye organized City National's oil and gas department in 1945, after holding executive engineering positions with the Tide Water Associated Oil Company.

Chicago-Wilcox Appoints California Distributor

The appointment of PenPower, Inc., to handle sales and service on gaskets, shims and washers in California has been announced by Chicago-Wilcox Manufacturing Company.

PenPower maintains Los Angeles headquarters at 1135 West Huntington Drive, Arcadia, and a San Francisco district office at 340 Lorton Avenue in Burlingame.

Hercules Tool Company Completes Expansion

Hercules Tool Company recently completed an expansion program begun in July, 1955. The office building and plant in Tulsa were enlarged and additional equipment was purchased. Adjoining ground for future expansion also was acquired.

Supervisory personnel is as follows: L. C. Rhoads, vice president; Ivan L. Ingold, secretary and assistant treasurer; William H. Sage, Jr., recently advanced to operations manager; Hoyt K. Anderson, promoted to inventory control manager; Charles E. Montgomery, new office manager; and Clarence E. Copeland, warehouse manager. Walter H. Cox and Thomas E. Marshall have been added to the sales staff.

Oilfield Sales & Service, S.A. Appointed BJ Representatives

Oilfield Sales & Service, S.A. is the newly-appointed Venezuela-Colombia sales representatives for Byron Jackson oil tools and oil field rubber products. In addition to representing the full line of BJ tools and products in Venezuela and Colombia, Oilfield Sales & Service, headquartered in Maracaibo, will act as dealers for Byron Jackson "stretch-on" type casing protectors in Venezuela.

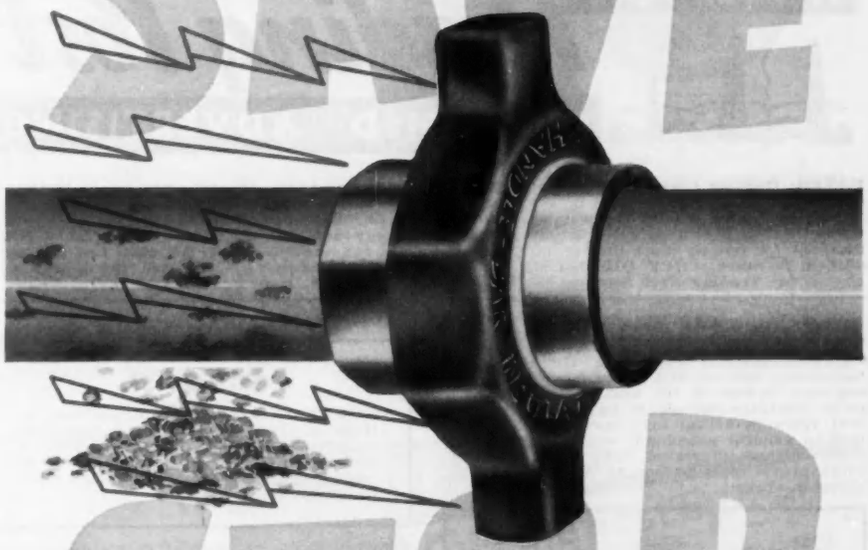
Jerry Kearby and Dave Alexander of Oilfield Sales recently completed a special product orientation course at the main Los Angeles plant of Byron Jackson.

NEW CLAYTON MARK & CO.

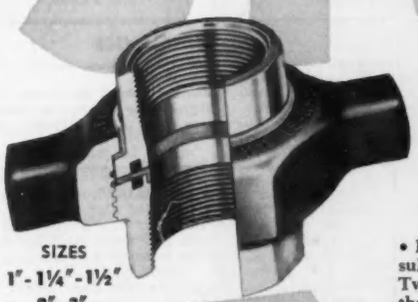
FORGED STEEL

INSULATING HANDLE-BAR UNIONS

SAVE DOLLARS AND DOLLARS OF MATERIAL WASTE – REPAIRS AND PIPING REPLACEMENTS



STOP ELECTROLYTIC ACTION FROM DESTROYING PIPELINES BY CONFINING COSTLY CURRENTS



SIZES
1"-1¼"-1½"
2"-3"

Contact your local supply store for prices and additional information on these and other Forged Steel Unions. Ask about our complete line of Forged Steel and Alloy Fittings.

SOLVE YOUR PIPELINE INSULATION PROBLEMS with this NEW CLAYTON MARK UNION!

For years oil field production lines have required costly replacements due to the ravages of galvanic and electrolytic action. This action carries away many pounds of metal each year. Causes for this damage by uncontrolled currents are many and varied. Positive insulation between sections of pipe will provide cathodic protection for the entire pipeline. The New Clayton Mark INSULATING HANDLE-BAR UNION does this job...Superbly!

• Designed and constructed to provide positive insulation on pipe lines up to 3000 lbs. C. W. P. • Two oil-resistant "O" rings form the seat between the male and female ends. • Insulating gaskets are nylon fabric, impregnated with Hycar rubber, that remain pliable after long service. Shoulders maintain perfect center positioning of the gasket. This positioning also prevents damage to the gasket as union is assembled. • Insulating Handle-Bar Unions have Cadmium plated ends and a Parkerized nut.

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Emsco Manufacturing Signs French License Agreement

Emsco Manufacturing Company announces the licensing for the manufacture and sale in France and French territories of Emsco oil well drilling rigs and engine transmissions by Societe Nationale de Materiel pour la Recherche et l'Exploitation du Petrole (SN. MAREP).

William T. Powell, president of Emsco, and D. M. Bailey, vice president and general counsel of Continental Supply Company, world distributors for Emsco, signed the license agreement with F. Emmanuelli, president and general manager of SN. MAREP.

SN. MAREP manufactures and distributes equipment and drilling materials for the European market. Emsco will furnish technical assistance necessary to the engineering of equipment fabrication.

Caterpillar Tractor Dedicates New Plant at Decatur, Ill.

The world's largest motor grader and wheel type tractor plant was dedicated in Decatur, Ill., the week of May 21-25 by Caterpillar Tractor Company. Built to accommodate production of wheel-type tractors and motor graders and to release facilities at Peoria for added output of crawler tractors and diesel engines, the new plant is situated on 425 acres less than a mile northeast of Decatur.

Two main buildings provide more than 840,000 square feet of manufacturing and office space. The manufacturing building —730,400 square feet in area—is double-walled and equivalent to two stories high all along its 830-foot width and 880-foot length. Two assembly lines extend nearly the entire length of the plant.

Adjoining the front half of this building is a two-story brick administration building which provides 53,581 square feet of office space on two floors. This building houses in addition to most of the plant offices, the medical section and 255-person auditorium.

International Harvester Changes Name of Division

The Industrial Power division of International Harvester Company now is known as the Construction Equipment division. The change applies to name of division only and does not affect personnel or line of equipment.

Crawler tractors; industrial wheel tractors; two-wheel, high-speed earth movers; towed scrapers, bulldozers, front-end loaders; engines; and off-highway trucks, will continue to be marketed under the new division name of Construction Equipment division.

Continental Supply Holds 16th Annual Sales Meeting

Continental Supply Company's sixteenth annual sales meeting, recently held in Dallas, was attended by representatives of Continental's associated manufacturers and by 175 Continental men from the U. S., Canada and South America. Business sessions conducted the first day concerned various phases of merchandising drilling equipment, production equipment and tubular goods.

J. M. Tuthill general manager of sales, and Dr. Karl L. Fetters, assistant to the vice president, both of The Youngstown Sheet and Tube Company, were among guests present. Continental is a division of Youngstown.

Macwhyte Company Opens Mill Depot in Detroit

Macwhyte Company, wire rope manufacturer, has a new office and warehouse in Detroit located on Oakman Boulevard. Complete handling and cutting facilities have been installed for quick pick up and delivery of a wide range of sizes and types of wire rope used in the Detroit area. This factory stock is supplementary to stocks and services by Macwhyte Company distributors and has been established to give factory service to Macwhyte Company distributors and customers.

American Iron & Machine Names South American Agents

American Iron & Machine Works Company, Inc., has announced the appointment of two sales agents in South America. Norman E. Yett and Verne Yett will represent American Iron in Venezuela. The company, Norman E. Yett and Associates, will cover all oil producing areas in Venezuela and will have headquarters at Caracas.

Pio Castagnoli will act as sales agent for American Iron in Brazil. His company, SONDA, covers production areas within the country of Brazil with main offices in Rio De Janeiro.

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RATES: Regular Classified (undisplayed) **set** in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Situation wanted ads,** 6 cents per word. **Display ads,** set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance. COPY DEADLINE:** 17th of month preceding date of issue. Send copy and checks to: **Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.**

HELP WANTED

■ EXPERIENCED Petroleum Engineer. A technically trained and experienced petroleum engineer is needed for unit operations. Must be a graduate petroleum engineer with several years in actual field operations in addition to general petroleum engineering experience. Anyone interested, with these qualifications, please reply to Box 95-W, WORLD OIL, Houston, Texas.

A LEADING LOS ANGELES BANK

Has an opportunity for an attorney experienced in legal work for the petroleum industry.

In replying please send resume of experience and qualifications.

Write Box 102-W, WORLD OIL, Houston, Texas.

■ WANTED: Man for teaching staff and part-time research in Petroleum Engineering at Rocky Mountain School. Should have M. S. or better and some oil industry experience. Salary open. Reply to Box 100-W, WORLD OIL, Houston, Texas.

FOR SALE

■ BIG RANCHES. We have inspected these recently: Montana, 30,000 and a 10,000 acre deal. Colorado, 7,700 and 24,000 acres. New Mexico, 10,000 to 13,000 acres. Picturesque and productive, low prices for deeded land, carry good loans. Ranch specialists, contact us for big ranches anywhere. R. C. Jones Real Estate, Box 3155, San Angelo, Texas. Phone 6457.

EQUIPMENT WANTED

■ WANTED—Three large churn drill rigs, similar to Bucyrus-Erie 36-L or 48-L. Please give reasonably complete information and also where rigs can be inspected. Box 103-W, WORLD OIL, Houston, Texas.

SITUATIONS WANTED

GEOLOGIST

Gulf Coast experience, consulting in Houston, Texas, wants firm connection with independent oil operator or drilling contractor to drill prospects. Equitable basis. Write Box 99-W, WORLD OIL, Houston, Texas.

■ EXECUTIVE SECRETARY: Single, now employed, but limited future with present firm. Experienced, aggressive, loyal, and desirous of making better connection, preferably with independent. Box 101-W, WORLD OIL, Houston, Texas.

■ DRILLING SUPERINTENDENT with administrative ability, 20 years' experience in Mexico and South America seeks position, preferably outside the United States. Box 104-W, WORLD OIL, Houston, Texas.

BUSINESS SERVICE

■ **Delaware Corporations formed and serviced** Inquire without obligation. American Guaranty & Trust Company, 910 West Street, Wilmington, Delaware.

Well organized, well established oilwell drilling contractor desires the management and supervision of oil properties in West Texas, Central Texas, and New Mexico. Can provide complete handling of oil properties, from acquisition to production. No properties too small, and none too large to handle. Inquiries from independents, groups, small or medium sized oil companies invited. Write, wire, or call collect for further information.

MAKIN DRILLING COMPANY

P. O. Box 1628, Hobbs, New Mexico, Phone 3-3141
146 Allen Building, Midland, Texas, Phone 2-2962

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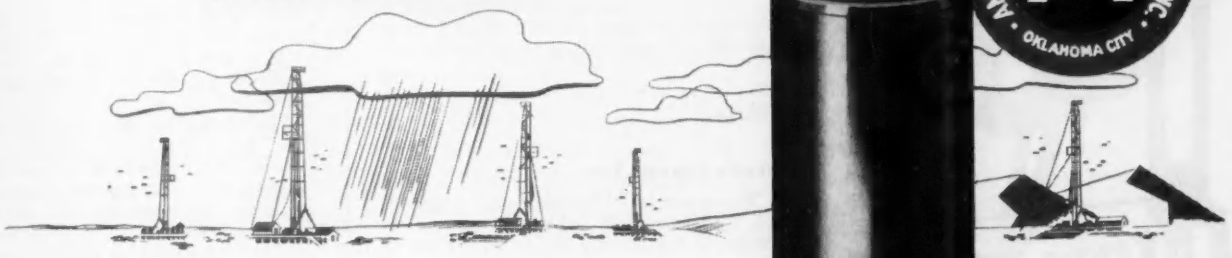

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BASIC OIL GEOLOGY

By WILLIAM W. PORTER, II

This concise, easy-reading analysis of geology is a revision of an earlier book, The Practical Geology of Oil. The author is a member of the American Association of Petroleum Geologists and a member of the American Institute of Mining and Metallurgical Engineers.

This 144-page cloth-bound book in the handy size of eight inches is illustrated with 21 photographs, cross sections, drawings and maps. Subject matter, as indicated by chapter headings, touches upon the fundamentals of geology, elements of an oil field, common minerals, rocks, erosion, geological time, fossils, sedimentation, the crust of the earth, structural geology—folding and faulting, concentration of oil, unconformities, methods of drilling, well logging, coring, gromation testers, geophysical methods, productivity of oil fields, and sources of geological information. Price $4.

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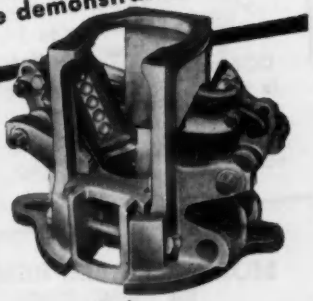

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SQUEAKS from the BULLWHEEL

Evening Prayer

"And please, God, make that big bully, Johnny, next door quit picking on me. By the way, God, I've mentioned this twice before."

History?

Stopping at the first house on his famous ride, Paul Revere cried, "Is your husband home?"

"Yes," came the answer.

"Then tell him to dress and come to help fight the British."

At the second, third and fourth houses, he repeated the conversation. As he rode by the fifth house, he again repeated the cry.

"No," was the reply.

"Whoa."

Mirrors Never Lie

A Tennessee hillbilly discovered a mirror which had been left behind by a tourist.

"Well, if it ain't my old pappy. I never knowed he had his picture took!"

He sneaked it home and went up to the attic to hide it. But his wife spied him and that night, while he slept, she slipped up to the attic and found the mirror.

"Aha!" she exclaimed, looking into the glass. "So that's the old biddy he's been running around with."

Right Neighborly

"Mr. Jones, can Daddy borrow your corkscrew?"

"Sure thing, Johnny, just run along back home and tell him I'll bring it over."

Right Train

After arriving at the railroad station, the three men learned that the train was late, so they decided to go across the street for a drink. One led to another and when they finally crossed back to the station the last call was coming over the public address system. They made a run for it, but one fell, while the other two caught the last coach.

When attendants got to the victim of the fall, they found him laughing and explained his joy like this:

"You know, those two guys just came down here to see me off."

Give Credit

A millionaire was being interviewed about his selfmade fortune.

"I never hesitate to give full credit to my wife for her assistance."

"And just how did she help?" asked the reporter.

"Frankly," said the millionaire, "I was curious to see if there was any income she couldn't live beyond."

Life Span

It's really several years, but it seems like only a fleeting moment, between your teaching the small boy to ride a bicycle and his telling you how to drive the car.

Hold That Tiger!

The receptionist and others were thrown into a state of excitement at The Gulf Publishing Company's Houston offices late in May when Jack Morris, formerly with Shell Petroleum Company, Western Venezuela, appeared with a cage and said to the telephone operator:

"Please tell Mr. Ray Dudley that Jack Morris is here with a tiger for him!"

"A what!" exclaimed the telephone operator.

"A tiger," replied Mr. Morris. "Tell Mr. Dudley I brought him a tiger."

The telephone operator explained that Ray Dudley, publisher of WORLD OIL, was in the East on a business visit so Morris asked to speak to his secretary. The routine was repeated and a highly excited secretary dashed up to the receptionist's desk to see "tiger." It was a tiger cub but it was hardly bigger than a kitten, being only three months old! Morris said that Glenn McCarthy had shot the mother and that he, Morris, had brought the baby back with him from Paraguay.

They Come Cheaper

The president of the company was showing a friend through his offices.

They went past a series of small private rooms in which young men were busily hammering away at typewriters.

"These are some of our junior executives," said the president.

"But they're typing letters," said his friend.

"Sure," replied the president, "I can get junior executives today for half the price I have to pay stenographers!"

WORLD OIL

"Black stuff keeps a 'squirtin out of the ground. Gives Pa a mite of trouble keeping it stopped up."

Over 60 *Locations in the United States and Canada*

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New Services • • • New Tools • • • New Methods • • • Outstanding Results

McCullough Back-Off Service Aids in Recovery of an Extra 3600′ of Stuck Pipe

In some stuck pipe conditions McCullough's Magna-Tector (Free Point Finder) will indicate that working the pipe may free it further down the hole. In this instance the stuck drill pipe was actually loosened 3,600′ below the original sticking point.

Operator was drilling at 5,668′ with 3½″ Full Hole Drill Pipe when pipe stuck. This was a 32° angle directional well.

McCullough was called to run their combination Magna-Tector, String Shot Back-Off. Lowest free point was found at 1,900′. However, the Magna-Tector reading indicated that the drill pipe might be freed further down the hole.

Pipe was worked for 2½ hours and the combination Magna-Tector, String Shot Back-Off was again run. Pipe was found to be free at 5,500′ at the top of the drill collars. The String Shot Back-Off was positioned and fired and pipe was recovered from that point – a bonus of 3,600′ of drill pipe.

McCullough's new combination "One Trip" Back-Off Service obtained the free point reading and fired the back-off shot on a single trip in the hole. Thus, all free pipe was backed off and started out of the well almost immediately after the lowest free point had been found – and before it had a chance to re-stick further back up the hole.

Magna-Tector Helps Save 12 Days Fishing Time on Stuck Pipe Job

Operator Estimated 21 Days to recover 7760′ of Stuck Drill Pipe — Job Actually Completed in 9 Days with Aid of McCullough Back-Off Service.

The time-saving benefits of McCullough Back-Off Service in pipe recovery operations were strikingly demonstrated in this deep California well.

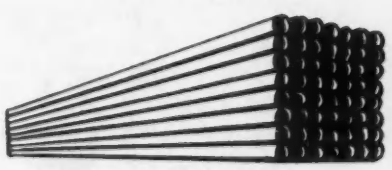
Operator was drilling at 11,360′ when 4½″ O.D. drill pipe became stuck. Only surface casing had been set and hole was open from 500′ to 11,360′.

McCullough was called immediately. The Magna-Tector (Free Point Finder) located the lowest free point in the stuck string at 3,600′. A String Shot Back-Off was fired at that point and the free pipe was removed from the hole.

At the time of the first back-off the Drilling Superintendent advised his head office that it would require an estimated 22 washover operations, 22 String Shot Back-Off shots and 21 days of rig time to recover the remaining 7,760′ of stuck drill pipe. However, due to reliable free point determination, the job was completed in only nine days. After each washover operation, McCullough's Magna-Tector was run to confirm that the washed-over pipe was free. In each instance the Magna-Tector discovered that pipe was free a considerable distance below the lowest washover point. McCullough's String Shot Back-Off successfully loosened the lowest free joint in every case and permitted fast recovery of the freed sections.

SAVE TIME

SAVE MONEY



SAVE PIPE

Instead of 22 separate washover and back-off operations, the use of McCullough Back-Off Service enabled completion of the job in only four recovery operations.

Count the savings this operator made through his foresight in calling for McCullough Back-Off Service. Saved – 18 String Shot Back-Off shots – 18 separate washover operations – 12 days rig time.

It pays to call for McCullough Back-Off Service. You'll save time – save pipe – save money!

Call for–McCULLOUGH BACK-OFF SERVICE

McCullough "One Trip" Back-Off Service is now available in most service areas – performs all back-off operations in one electric wire line run in the hole – ask your McCullough Service Engineer.

McCullough® TOOL COMPANY

Cable Address: MACTOOL

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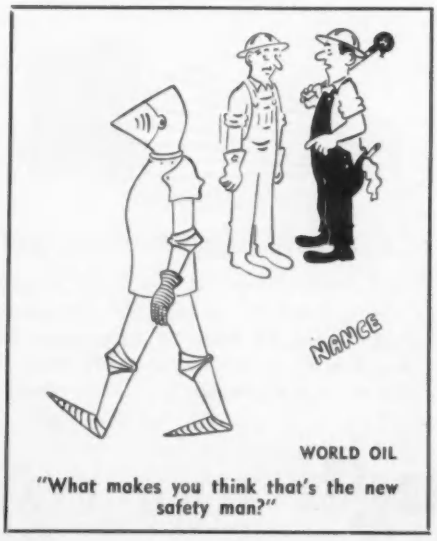

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"I sure would like to move into that apartment house that's going up across the street," commented Dick. "They say there's going to be a venetian blond in every window."

Diagnosis

Psychiatrist to sad-eyed patient, "My dear fellow, you have no complex. You are inferior."

Management

"Why not marry," said Mr. Newlywed to the woman hater, "and have a wife to share your lot?"

"It sounds all right," was the reply, "but some of these shareholders blossom into directors."

Weaker Sex

Women may be the weaker sex but they can still put the cap on a fruit jar so that it takes a man 20 minutes to take it off.

The Other Weakness

The weary salesman finally found a bus seat beside a shapely traveler, who had trouble keeping her skirt from crawling a bit too high. She tugged at it frequently and without too much success.

Finally the salesman put her at ease by saying:

"Don't stretch your calico, sister. My weakness is liquor."

Drill at Will

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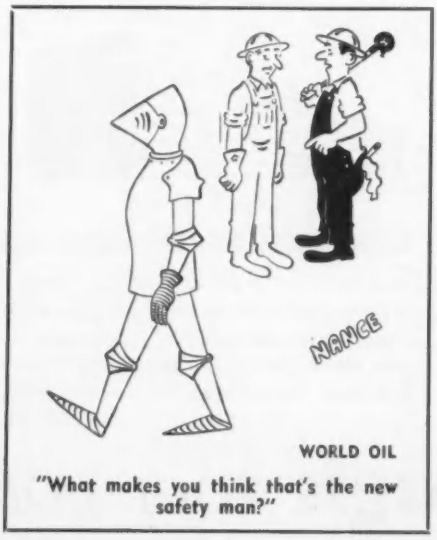

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Saleslady: "Here are some lovely items. Frankly, this is the only place you can touch them for anything near the price."

Added Incentive

"I sure would like to move into that apartment house that's going up across the street," commented Dick. "They say there's going to be a venetian blond in every window."

Diagnosis

Psychiatrist to sad-eyed patient, "My dear fellow, you have no complex. You are inferior."

Management

"Why not marry," said Mr. Newlywed to the woman hater, "and have a wife to share your lot?"

"It sounds all right," was the reply, "but some of these shareholders blossom into directors."

Weaker Sex

Women may be the weaker sex but they can still put the cap on a fruit jar so that it takes a man 20 minutes to take it off.

The Other Weakness

The weary salesman finally found a bus seat beside a shapely traveler, who had trouble keeping her skirt from crawling a bit too high. She tugged at it frequently and without too much success.

Finally the salesman put her at ease by saying:

"Don't stretch your calico, sister. My weakness is liquor."

Drill at Will

SAND-BANUM

Pure Colloidal Concentrate

Ounces Only Once A Week
REMOVE and PREVENT
Boiler Scale and Corrosion

More Power Less Fuel
Fewer Shut-Downs

For Diesel Cooling Systems Use
SAND-BANUM SPECIAL
in the Handy Tablets

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Western Sand-Banum Company
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Colloid Products Co.
2825 Storey Lane, Dallas, Texas

AMERICAN SAND-BANUM CO.
ESTABLISHED 1926
MEADOW BROOK NATIONAL BANK BUILDING
FREEPORT, NEW YORK

BrakeSol

ELIMINATES COSTLY PARAFFIN REMOVAL METHODS

HOLDS PARAFFIN IN SUSPENSION
from FORMATION to REFINERY

BRAKESOL is economical and safe to use, prevents and removes paraffin from the tubing, flow lines, tank bottoms and pipe lines. Effective on both asphalt and mixed-base paraffin.

FOR SERVICE CONTACT YOUR NEAREST BRAKESOL SALES ENGINEER

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The National Supply Co
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LOVINGTON, NEW MEXICO 6-5954
NEW IBERIA, LOUISIANA EMerson 9-3498
ODESSA, TEXAS 2-2575 7-7192
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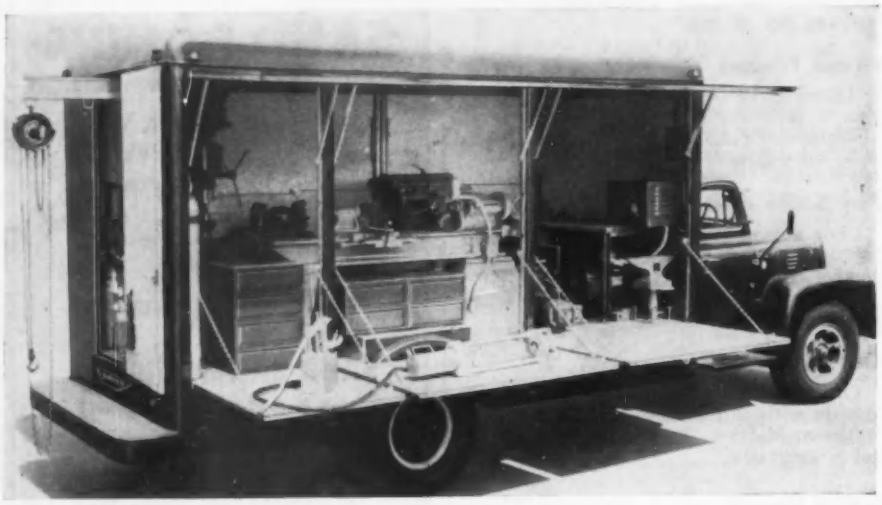
BRAKESOL, Inc.
P.O. Box 9506 Okla. City, Okla.

What's New In Equipment

Drilling • Production • Exploration



Mobile Machine Shops

A new line of mobile machine shops, designed to meet the needs of virtually every type of user operating over extensive areas, is announced by Davey Compressor Company.

Shop assemblies vary from relatively simple items of power equipment to large collections of tools and accessories. Basic units are Davey air compressors and power and welding generators. These are driven direct from the truck engine through a heavy-duty power take-off. Shops can be mounted on almost every make and model of truck.

For more data, circle **No. E1** on Reader's Service Card, last page this issue.

Drill-Hole Logger

Mount Sopris Instrument Corporation's new Model GHL-230 logging system includes a portable reel, a Geiger counter with a water-tight probe and a recorder which provides a record of radiation intensity as a function of depth in the hole.

All bearings, drive mechanisms and slip-rings of the reel are totally enclosed as protection against dirt and moisture. Drive for the footage indicator and recorder chart movement is positive and without backlash. The probe is positioned with respect to the hole by means of a boom which extends forward from the reel. In transport, the boom folds down inside the reel.

The probe, designed around the type S Geiger tube manufactured by the N. Woods Counter Laboratories, is tested under water at a pressure of 1000 psi. Exceptional linearity makes the logger suitable for in-hole radio-assay applications. The Geiger counter also is water tight and has been designed to mount directly on the rear of the recorder.

The recorder-Geiger counter can be attached or detached from the reel in less than a minute, breaking down into two easily carried packages.

For more data, circle **No. E2** on Reader's Service Card, last page this issue.

Rust Remover

Turco Products, Inc., has developed an alkaline material for the removal of rust, paint and primer in one easy dip and rinse operation. The powdered compound, Turco Alkaline Rust Remover, contains no cyanide compounds. It requires no complicated electrolytic equipment and does not emit corrosive fumes. Hazards commonly encountered when charging acid tanks are eliminated. It will not affect dimensional tolerances or cause hydrogen embrittlement, and it requires no after neutralization, just a pressure rinse.

For more data, circle **No. E3** on Reader's Service Card, last page this issue.

Pipe Joining System

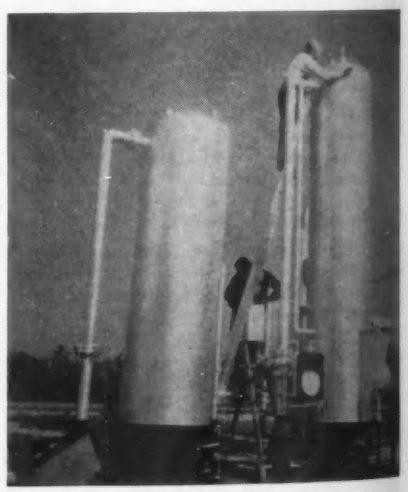
A new method for simple and efficient joining of Unitrace sections has been introduced by Aluminum Company of America. Unitrace, announced two years ago by Alcoa, is an integrally extruded steam traced aluminum pipe, which permits easy application of heat to product piping.

The new joining system involves a special cast flange which features a built-in product and steam tracing line.

To join two sections of Unitrace, the trace lines are cut back 2½ inches from the ends of the sections to be joined. Flanges are slipped onto each section end. Unitrace sections and flanges are joined by welding at the front faces and necks of the flanges using 4043 weld wire.

Two separate gaskets are used to seal the product and steam passages between the mating flanges. Bolt holes on these flanges will mate with standard 150 pound 2-inch ASA pipe flanges and fittings to permit easy joining to other piping and equipment. Condensate drains can be installed by drilling into the steam cavity of the flanges.

For more data, circle **No. E4** on Reader's Service Card, last page this issue.



Mobile Inspection Service

A mobile inspection service, able to determine condition of equipment by detection of flaws, fatigue or corrosion, has been announced by Sperry Western, Inc. In-place and on-the-site inspections are made ultrasonically, using the Sperry reflectoscope and reflectogage. The reflectoscope is used to determine defects in metals and other materials and will find discontinuities up to 30 feet in aluminum and farther in steel; the reflectogage measures thickness of metals and other materials up to four inches and is accurate to plus or minus 2 percent.

For more data, circle **No. E5** on Reader's Service Card, last page this issue.

Save time! Keep informed! Circle numbers on Readers' Service Cards, last page this issue.

W-K-M VALVE SURVIVES 3 DAY FIRE AND 3 NITRO BLASTS

When the roaring blaze of this burning gas well was finally snuffed out, workers went in to close the casing wing valve.

"The valve closed and sealed perfectly," said the production engineer for one of the well's three operators. "By shutting off one of the two streams of gas it made the job of closing in the well a lot safer and easier."

It was a W-K-M 2" series, 1500 Model L Valve. For 3 days it had been subjected to the intense heat of flames which had shot as high as 90 feet. It was jarred by three nitro blasts, which shook the earth as much as two miles away and scattered debris for more than a mile.

Only the metal-to-metal seals of the W-K-M Valve could withstand such an ordeal. Only the tolerances allowed by the parallel expanding gate could permit free movement after three days of intensive heat. Only the strength provided by the W-K-M design could survive the jarring impact of the nitro blasts.

You may never have a fire — but you should have assurance that the valves you use provide the greatest possible safety factor in any emergency. W-K-M is such a valve. Ask your W-K-M Representative.

5607

W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF ACF INDUSTRIES INCORPORATED

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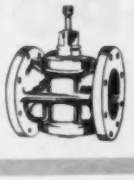
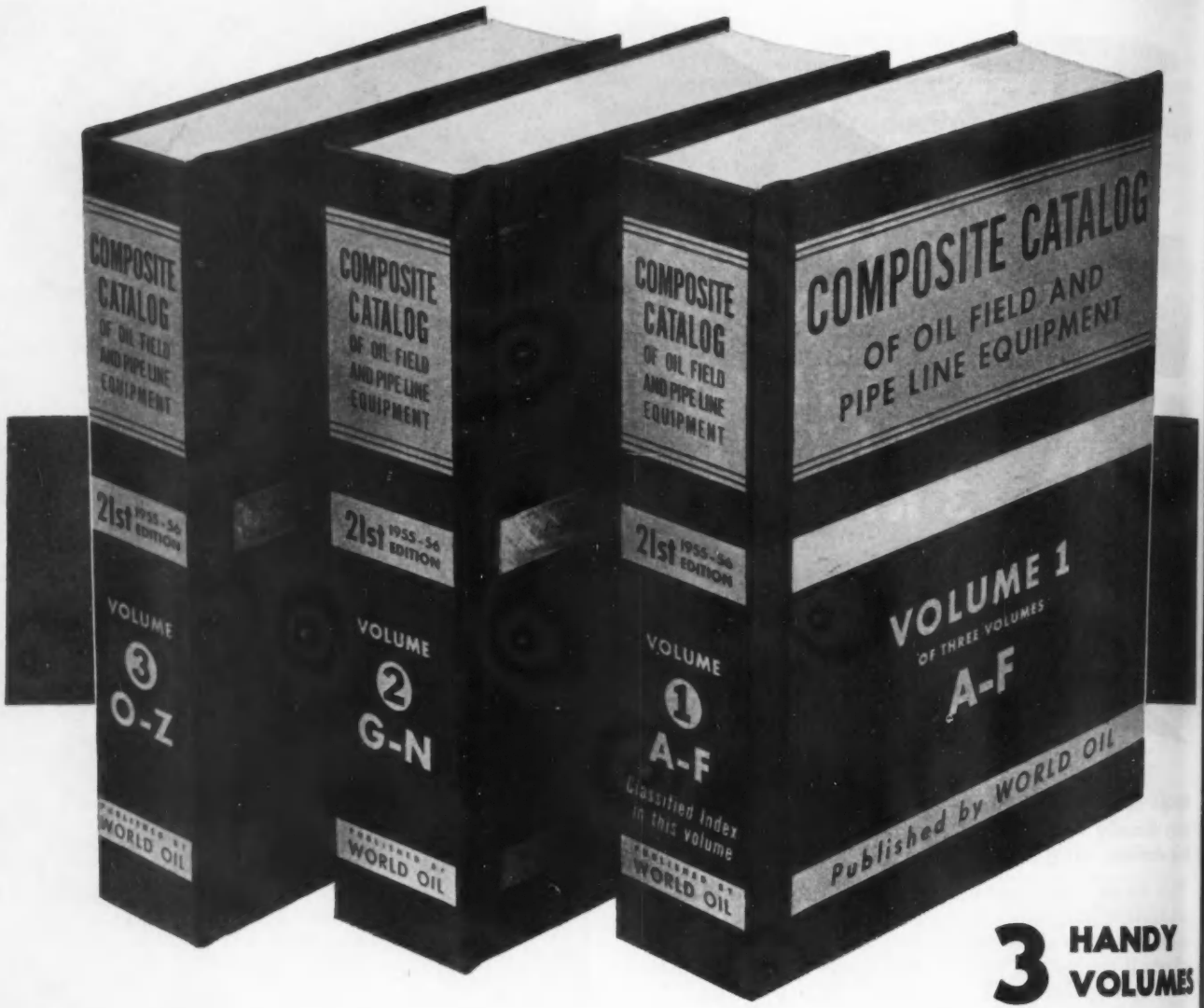
MANUFACTURING

W-K-M THROUGH-CONDUIT GATE VALVES

acf LUBRICATED PLUG VALVES



KEY RETURN BENDS AND FITTINGS



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Now in three handy volumes, the 21st Edition of *The Composite Catalog of Oil Field and Pipe Line Equipment* is bigger, better, more convenient than ever. Twelve thousand men throughout the industry refer to it constantly to buy and specify equipment or services. When you're in a hurry (and what oil man isn't), remember to look first in *The Composite Catalog.*

— THE COMPOSITE CATALOG —

THE ready source of equipment information

THE COMPOSITE CATALOG

OF OIL FIELD AND PIPE LINE EQUIPMENT

Complete . . . Than Ever

Here's what you'll find to make your job easier in the new 3-volume edition of *The Composite Catalog*:

- 550 Manufacturers and Service Companies, complete or condensed catalogs.
- 3,000 products and services, indexed and cross-indexed.
- 5,392 total pages, containing catalog data on specifications, weights, dimensions, applications you can use right on the job.

In ordering equipment, refer to it by page number in *The Composite Catalog,* for faster, better service.

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Be Safe —
IT'S A KING
YOU ALWAYS HAVE
Control
WITH A
KING
Wire Line Stripper (Auto-Releasing)
POSITIVE LATCH
will not release by accident or surge of pressure.
SURE RELEASE MECHANISM
operated by rope socket striking bottom of stripper.
NON-SPARKING MATERIALS
eliminate hazard of fire from this tool.
CONVENIENT HAND HOLDS
makes for easier handling at all times.
PACKING IS SELF-CENTERING
compression screws need not be evenly adjusted.
SIDE OPENINGS
permit repacking while the wire line is in the hole.
These wire line strippers represent an outstanding advance in design and construction of tools in this class.
Sometimes referred to as "wipers" or "oil savers", they provide the oil industry many advantages that were not previously available.
EXPORT: R. S. STOKVIS & SONS
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KING OIL TOOLS
P. O. BOX 15146 • HOUSTON 20, TEXAS • ORchard 3-3421

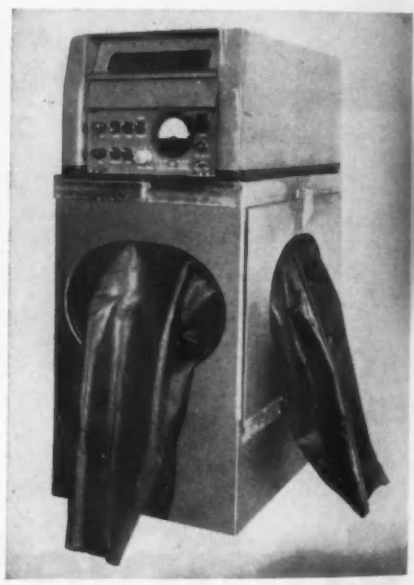
Aircraft Tires

Low pressure pneumatic tires, Terra-Tires, are undergoing tests by The Goodyear Tire & Rubber Company for use on light planes facing the hazards of getting in and out of unimproved areas. Complete undercarriage of a Stinson Voyager was redesigned to incorporate the two 24-inch wide flat-sided low pressure tires, complete with brakes. Operating pressure during tests varied from three to eight pounds per square inch.

The tires are designed to allow airplanes to operate in and out of plowed fields, clearings and other rough ground not cluttered with major obstacles, ice and snow-covered areas, as well as marshy and sandy regions.

Advantages of Terra-Tires include thin, extremely pliable walls, combined with extremely low pressure, which enables the tires to absorb or conform with uneven surfaces without resisting them and to glide over soft, giving surfaces without bogging down.

For more data circle **No. E6** on Reader's Service Card, last page this issue.



Seismograph Camera

An all-purpose seismic recording oscillograph, designed to operate with all seismic recording techniques, is announced by Houston Technical Laboratories. For high, conventional or low frequency seismic recording, or use with magnetic recorder, the RS-8U camera has complete operational latitude.

Paper speed changes for the respective seismic techniques are made with a flip of a control panel switch: Very low Frequency Refraction—6.6 inches per second; Conventional Reflection—13 inches per second; and High Resolution Reflection—32.4 inches per second. (Paper speeds may be varied ± 50 percent from these speeds by resetting governor). Paper speed can be switched during a record, with the change effected in 0.02 second. Paper speed is maintained to less than 1 percent deviation.

Light intensity in the camera changes automatically with each paper speed position. Rheostat adjustment of both timing light and galvanometer light is provided so intensities may be set as desired.

For more data circle **No. E7** on Reader's Service Card, last page this issue.

ONE OF THESE WECO UNIONS FITS YOUR NEEDS EXACTLY

Fig. 100
1000 psi
Sizes: 2"-8"

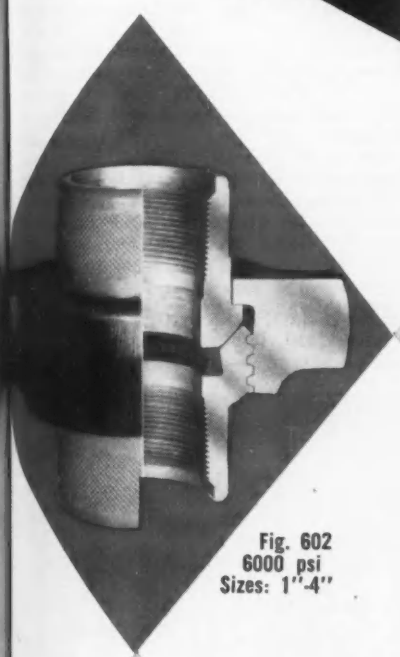


Fig. 602
6000 psi
Sizes: 1"-4"

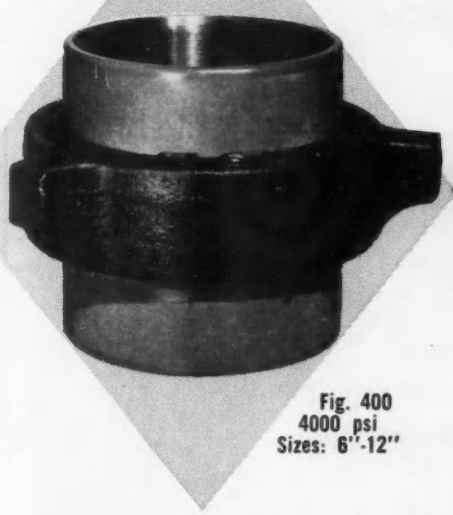


Fig. 400
4000 psi
Sizes: 6"-12"

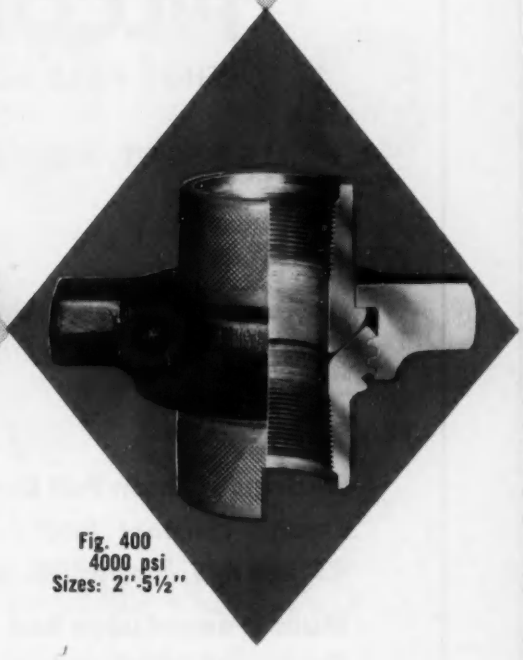


Fig. 400
4000 psi
Sizes: 2"-5½"

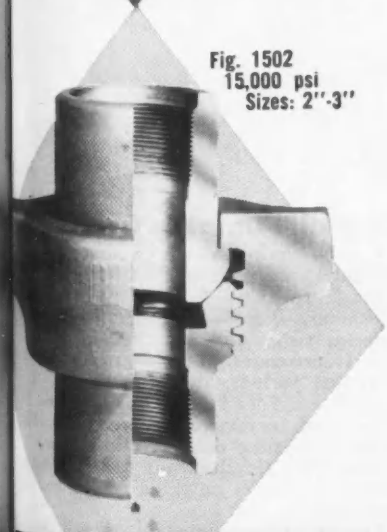


Fig. 1502
15,000 psi
Sizes: 2"-3"

Whether it's for high or low pressures on rig connections or production hook-ups, one of these Weco Unions, in sizes from 1" to 12", pressures from 1000 to 15,000 psi, is designed to do the job better . . . last longer . . . cost less in the long run.

Weco's ball and cone seat is unmatched for dependable leak-proof connections. The rugged Acme threads make-up and break-out fast and easy. The sturdier construction of Weco Unions takes the toughest service as a matter of course. They are available at supply stores everywhere.

U-3-56

WECO®

WELL EQUIPMENT MFG. CORP.

HOUSTON, TEXAS

Division of CHIKSAN COMPANY *a subsidiary of*
FOOD MACHINERY AND CHEMICAL CORPORATION

PESA
PETROLEUM EQUIPMENT SUPPLIERS ASSOCIATION
PARTNERS IN PETROLEUM PROGRESS

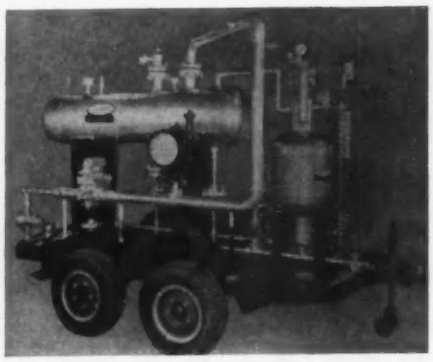
fmc
FOOD MACHINERY AND CHEMICAL

PRODUCTION

Well Tester

Oil Metering and Processing Equipment Corporation has designed a trailer-mounted well tester equipped with a type BV VOL-U-METER. The high pressure unit, which separates well fluid into oil, gas and water, meters each and has tie-in lines so that the oil, gas and water may be discharged separately or re-combined.

The tester has a working pressure of 1200 psi. The separating vessel on this unit has a 24-inch OD and is seven feet long. The horizontal unit is equipped with a 4-inch gas run and has a 1200 bpd and a maximum water capacity of 600 bpd.



For more data, circle **No. E8** on Reader's Service Card, last page this issue.

Coupling

A new type coupling which can be laid without need for coupling pullers or other mechanical devices is now available with Century asbestos-cement pipe. Announced by South Chester Tube Company, the coupling features newly-designed self-energizing rubber gaskets. An increase in internal pressure of fluid being carried causes these gaskets to swell and fit more tightly against both pipe and coupling, thus building extra resistance to leakage.

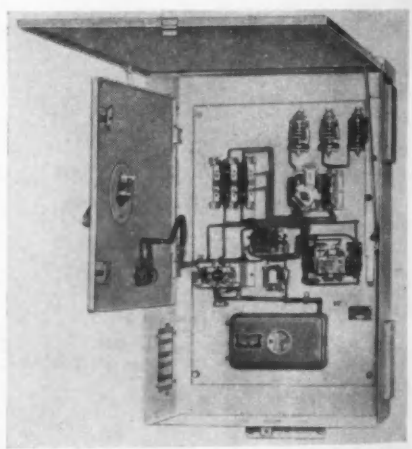
Normal make-up is accomplished with use of a crowbar. The pipe can be coupled in wet ditches and, under adverse conditions, the joining of pipe is done even more rapidly.

For more data, circle **No. E9** on Reader's Service Card, last page this issue.

Tank Gaging System

A remote tank gaging system, one of the Bendix Electro-Span systems, now is being produced by Pacific Division, Bendix Aviation Corporation. The simplified digital gaging system remotely measures liquid levels in tank farms of any size over a single wire-pair of any length leading to the tank farm area. It will read liquid levels to 64 feet in 1/8-inch increments. The system will read and hold or scan tank farms automatically. Average temperature can be determined and transmitted with the liquid level information. Cyclic timers can be used, also, to make readings at preselected times.

For more data, circle **No. E10** on Reader's Service Card, last page this issue.



Oil Well Pumping Control

A new controller design bringing full automation to oil well pumping is announced by Cutler-Hammer, Inc. The supertimer, heart of the new controller, performs two major functions in a single unit. It programs pumping operations in 15-minute periods, and it provides 73 accurately controlled restarting intervals in 2½ second increments from zero seconds to as much time delay as three minutes. Unfortunate, simultaneous restarting of a number of pumps on the same power line is avoided.

The first fully-automated oil well pump control, it makes co-incidental restarts following service interruptions impossible, and provides precise sequence restarting, adjustable restarting periods, delay timing, and manual or automatic restarting features.

For more data, circle **No. E11** on Reader's Service Card, last page this issue.

PILCON 650

SHOT HOLE MUD FLUSH RIG

DRILLS 650 FT. 4⅞" HOLE

WHY PILCON?

Designed for low maintenance cost and trouble free service.

FEATURES

Hydraulic Chain Pull Down

Ensures constant feed from zero to 42" per min. Exerts 6000 lbs. pressure.

Main Transmission Box

Fitted with silent running single helical gears.

Literature, field test data and specifications will be supplied on request

British Manufactured By

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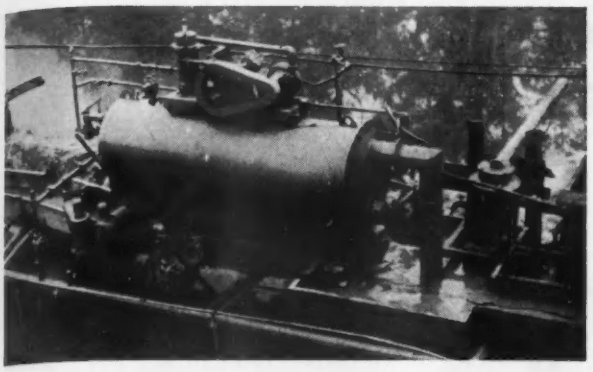

SWACO TOTAL MUD D-GASSER

Removes all the gas from all the mud

- Reduces blowout hazards
- Reduces mud costs
- Saves lost rig time
- Reduces high funnel mud viscosities

Write for full information

SWACO SALT WATER CONTROL, INC.
A Sid Richardson Development Company
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Proved Superior

IN GRUELING TORQUE AND PRESSURE TESTS*

FOR CASING AND TUBING

One trial will convince you that KOPR-KOTE'S *exclusive* formula combining copper flake with metallic lead and graphite is the *only real compound improvement in recent years!* Unexcelled as an anti-seize and positive leakproof sealing compound. Gives amazing low torque breakout after years of sub-surface makeup. Unaffected by vibration, surge, impact or shock. Prevents coupling distortion. Completely dams thread roots without ball-up. Will not settle out in container. *Write for further information or see Composite Catalog.*

*Send for Technical Bulletin #3.1 describing pressure and torque tests.

JET-LUBE INC.

Unconditionally Guaranteed

WHY GAMBLE? STOP LEAKERS WITH KOPR-KOTE

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with one objective:

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IF you know any—or all—of these men, you know that they are fully capable of managing their respective Geolograph Service Companies. All have had many years of Geolograph Mechanical Well Logging experience.

Geolograph is proud of these managers, and the many men under their supervision. These managers are responsible for the good service you naturally expect—and get—when you specify Geolograph Mechanical Well Logging Service.

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MECHANICAL WELL LOGGING SERVICE
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USE KINZBACH WHIPSTOCKS AND MILLS TO SIDETRACK YOUR HEADACHES

Type "A" Mill

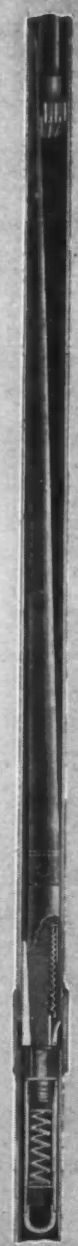
Type "D" Mill

Type "H" Mill

Type "I" Mill

Kinzbach Whipstocks can be set at any depth and require no support for the bottom. Positive setting slips prevent slipping or turning in the hole. The Kinzbach hinge arrangement assures that the top of the Whipstock will be close against pipe wall at all times, permitting easy passage of drilling tools. Setting trigger always locates the Whipstock between couplings so that the window will be within one joint. Kinzbach Whipstocks are available in all popular casing sizes through your supply store.

Use Kinzbach Milling Tools for every whipstocking or metal cutting operation. They have high-speed tool steel inserts which are ground and set at the most efficient angle for fast, uniform cutting action. Shown at left are four popular models—see your Kinzbach Catalog for a description of the complete series of Milling Tools.



KINZBACH TOOL CO INC

KINZBACH TOOL CO., INC.

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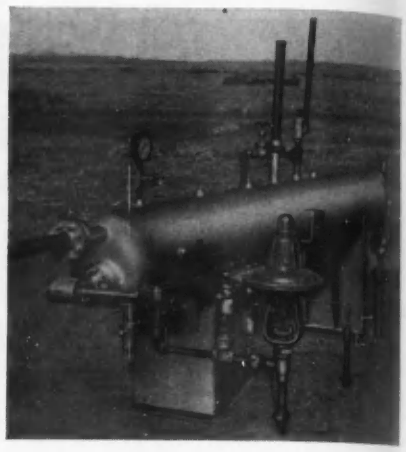


DC Separator

Black, Sivalls & Bryson, Inc. recently introduced the new DC horizontal separator for liquid and gas separation from high pressure oil and gas wells or other high pressure liquid and gas streams.

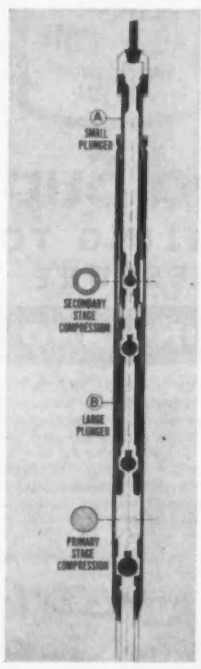
The separator features dual separation chambers in a single barrel and a special mist extractor of knitted wire mesh that combine to provide high separation efficiencies. Pressure drop across the separator and mist extractor is small. A new type inlet deflector produces maximum initial separation of liquid from the gas and permits in-line piping from the well stream inlet and gas outlet. All controls are mounted at the discharge end at standing level for easy adjustment and start up.

(This item supplements Black, Sivalls & Bryson, Inc. data on Pages 649-660 of the Composite Catalog, 21st Edition.)

For more data circle **No. E12** on Reader's Service Card, last page this issue.

Two-Stage Pump

Axelson Manufacturing Company's two-stage sucker rod pump has been designed for wells in which conventional pumping methods are inefficient due to high gas-oil ratio, gas locking, and in wells that must be produced from below a packer without gas separation. A rod-type pump with a stationary barrel, it actually is two pumps in tandem, a standard pump with a smaller one above it. The two chambers act directly opposite to one another. Area of the secondary chamber is one-third the size of the primary chamber, thus providing additional compression to the oil-gas mixture. Even under the most abnormal conditions, it is possible to obtain compression ratios at least three times greater than in normal pumps.



(This item supplements Axelson Manufacturing Company, Division of U. S. Industries, Inc., data on Pages 333-376 of the Composite Catalog, 21st Edition.)

For more data circle **No. E13** on Reader's Service Card, last page this issue.

Are you drilling a Wildcat Well?

PROVEN GEOPHYSICS

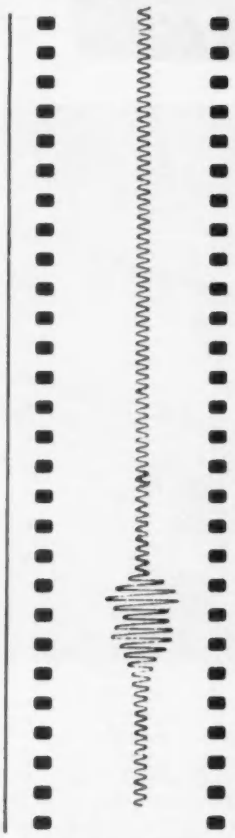
The New and Improved Amazing Attractometer

The latest and most modern method of geophysical exploration that shortens the route to petroleum reserves by rigid instrumental recordings, indicating the existence or not of hydrocarbon accumulations, and approximate depth. Ten locations for a major oil company without error. Surveys conducted for cash fee and chance to earn small override, oil payment, leases or other interest, where saturation is indicated in commercial quantities. Information on request.

To establish conclusive proof of the accuracy of our geophysical work, we will, without cost to you, test and record a log of your well on tape, bearing your signature and ours, of your rank wildcat location, in advance of drilling, indicating the existence or not of petroleum in commercial quantities underlying the tested areas and approximately at what depth it may be found. The instruments are entirely self-operating during testing period.

GEOPHYSICAL SURVEY SYNDICATE

4133 Sunnyslope, Sherman Oaks, Calif. Phone STate 46903



Specimen of log tape indicating saturation with break in zone

insist on the highest quality

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water cans and coolers

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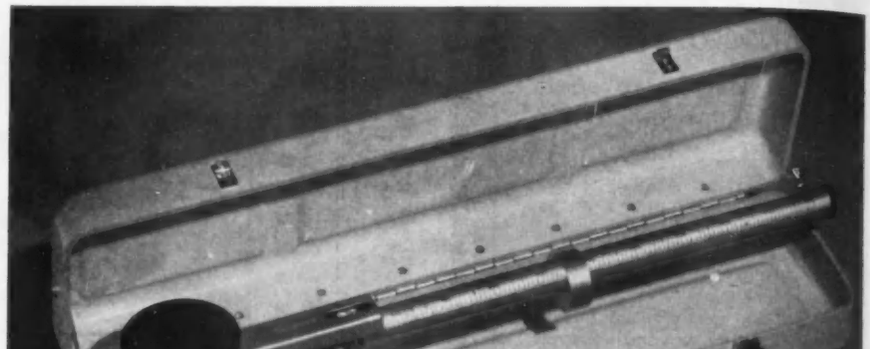
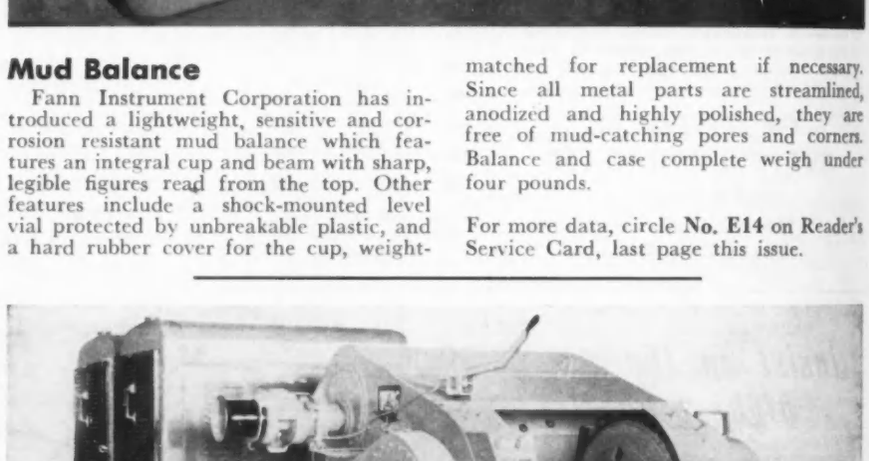


Mud Balance

Fann Instrument Corporation has introduced a lightweight, sensitive and corrosion resistant mud balance which features an integral cup and beam with sharp, legible figures read from the top. Other features include a shock-mounted level vial protected by unbreakable plastic, and a hard rubber cover for the cup, weight-matched for replacement if necessary. Since all metal parts are streamlined, anodized and highly polished, they are free of mud-catching pores and corners. Balance and case complete weigh under four pounds.

For more data, circle **No. E14** on Reader's Service Card, last page this issue.



Drawworks

Unit Rig & Equipment Company's new torque converter drawworks with rated maximum input horsepower of 600 is designed for drilling depths requiring horsepower range from 300 to 600, but can be used economically in areas where drilling requires less horsepower. The drawworks has a large, balanced drum for maximum wire line life.

For field moves, this unit is a compact, one package load that breaks into two packages for highway moves. One, two or three engines and compound, mounted on a common skid, comprise one load; drawworks complete with hydromatic brake makes up the second load.

Other features include fully enclosed water circulating brake rims of forged alloy steel; fully equalized, self-energized main drum brakes; and use of an air clutch for the catshaft drive to eliminate necessity of an inertia brake. On a double drum unit, this catshaft air clutch also allows use of positive clutch on sandreel and eliminates introduction of air through cathead. Control panel consists of only four air valves.

(This item supplements Unit Rig and Equipment Company data on Pages 4957-4988 of the Composite Catalog, 21st Edition.)

For more data circle **No. E15** on Reader's Service Card, last page this issue.

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New Equipment Catalogs and Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader's Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

V-Belt Brochure

V-Belts are the subject of a new bulletin issued by Worthington Corporation. Included are illustrations of the many Worthington-Goodyear types of V-belts available for drives employed in heavy industrial applications and miscellaneous machinery drives.

Featured are the steel cable belts which have the highest horsepower rating of any standard belt. They are especially adaptable for drives requiring extra strength and heavy continuous service.

The bulletin contains a complete listing of V-Belt sizes available.

To get a copy circle **No. E16** on Reader's Service Card, last page this issue.

Compressor Catalog

An engineering catalog describing the newest Cooper-Bessemer Type FMP compressor is now available. Built for field pick-up service, gas boosting, air drilling and general industrial use, the compressor is available with either single or twin frames, with single or multi-stage compressor cylinders. Ratings are up to 600 horsepower as belt-driven or completely packaged unit.

To get a copy circle **No. E17** on Reader's Service Card, last page this issue.

Measurement Equipment Catalog

Eighty devices are covered in a testing-instruments reference book recently published by General Electric's Instrument department.

The publication contains complete product information including applications, sources of additional information and pictures. Ranging from simple thickness gages to the mass spectrometer leak detector, there are instruments for research, production, laboratories and educational use. Measurement categories include color, leak detection, insulation and radiation monitoring.

To get a copy circle **No. E18** on Reader's Service Card, last page this issue.

Crude Oil Savings

"The Microballoon Layer Reduces Evaporation Losses" is title of a new booklet recently released by Bakelite Company, a division of Union Carbide and Carbon Corporation. Described are the tiny spheres of Bakelite phenolic resin filled with sealed-in gas, which, when pumped into a storage tank, form a surface blanket which cuts crude oil losses as much as 80 to 90 percent.

The booklet employs graphs, tables and photographic illustrations to describe the spheres and how they are packaged, shipped, stored, installed and maintained in crude oil tanks.

Bakelite Company produces these spheres under a license from The Standard Oil Company (Ohio) and markets them under the trade-mark Microballoon of Sohio.

To get a copy circle **No. E19** on Reader's Service Card, last page this issue.

New Products Data

Bowen Company of Texas, Inc., has issued folders on each of three products recently developed by the company. Illustration, description and operation are presented for the new Bowen-Itco lead seal casing patch, Itco lubricated drilling bumper sub and Itco automatic line wipers and wire line pressure controls. Product parts and prices are included in each bulletin.

To get a copy circle **No. E20** on Reader's Service Card, last page this issue.

Gamma Ray Logging

Performance of tools for simultaneous gamma ray logging and jet perforating by Birdwell Surveys are described in a Bulletin recently issued by the company. The bulletin lists advantages of the combination tool and associated instrumentation, gives examples of results obtained, and locations of field stations in Mid-Continent and Eastern oil fields.

To get a copy circle **No. E21** on Reader's Service Card, last page this issue.

Demineralization Article

Graver Water Conditioning Company has released a 24-page illustrated article on all phases of demineralizing. It discusses in detail advantages and disadvantages of this process for today's power plants.

Some of the developments, trends and applications of both multi-bed and mixed-bed ion exchange are discussed and case histories are used as examples. A comparison of the two types of demineralizing systems is presented as well as some of the important factors that go into the chemical and mechanical design and operation of these units.

The bibliography published at the end of the paper contains 119 separate sources of information on demineralizing and ion exchange.

In addition, the paper, which was originally presented at the Diamond Jubilee Annual Meeting of the ASME, contains several tables on such items as characteristics of anion exchangers, materials of construction, glossary of terms and specific conductivity of effluent. Flow sheets, descriptive drawings, performance curves, process selection charts and cutaway views also are included.

To get a copy circle **No. E22** on Reader's Service Card, last page this issue.

Switches Bulletin

A bulletin covering General Electric's complete line of control and transfer switches for low voltage applications up to 600 volts AC or DC now is available. Publication includes photos, drawings, cutaways and discussion of special features. Switches with water-tight and explosion-proof housings are described. Bulletin also contains application data, representative contact diagrams and ordering directions.

To get a copy circle **No. E23** on Reader's Service Card, last page this issue.

Cup Packings Bulletin

Extensive engineering and specifying data is contained in a bulletin on Darcova valve cups, seating cups and seating rings recently issued by Darling Valve & Manufacturing Company.

Included are tabular charts giving dimensions of cups for API barrels, also for some other common pumps of various sizes, recommendations as to the proper use of available cup textures and list prices covering the full range of Darcova valve cups, seating cups and seating rings.

To get a copy circle **No. E24** on Reader's Service Card, last page this issue.

Microfilm Library

Petroleum Research Corporation has issued a booklet describing their Micro-Research-Card technique of cataloging information. Illustrated is the Rocky Mountain Edition of their Geology Library which contains all the significant English language literature on Rocky Mountain sedimentary and petroleum geology, microfilmed in its entirety. The library includes pertinent articles from scientific journals and government publications as well as articles from semi-scientific journals, unpublished reports of the U.S.G.S. and other sources.

Instructions on how to use the Micro-Research-Card system, a map of the area covered, and an explanation of the coding system are included.

For more data circle **No. E25** on Reader's Service Card, last page this issue.

Conax Catalog

A catalog from Conax Corporation on thermocouple assemblies and pressure sealing glands introduces the new Conax check wells, Conax speedwells, Conax multiple wire thermocouple glands, Conax pressure sealing spring loaded thermocouples and Conax flex-tube assemblies.

In addition, the company's engineering and manufacturing facilities for fast delivery on special thermocouple assemblies are described.

For more data circle **No. E26** on Reader's Service Card, last page this issue.

Advertisers' Index

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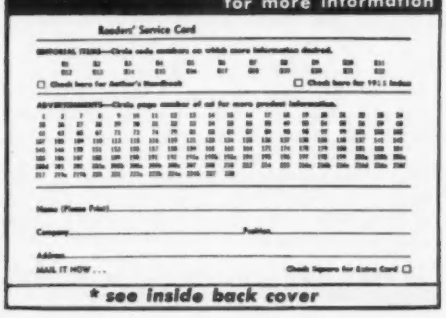
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